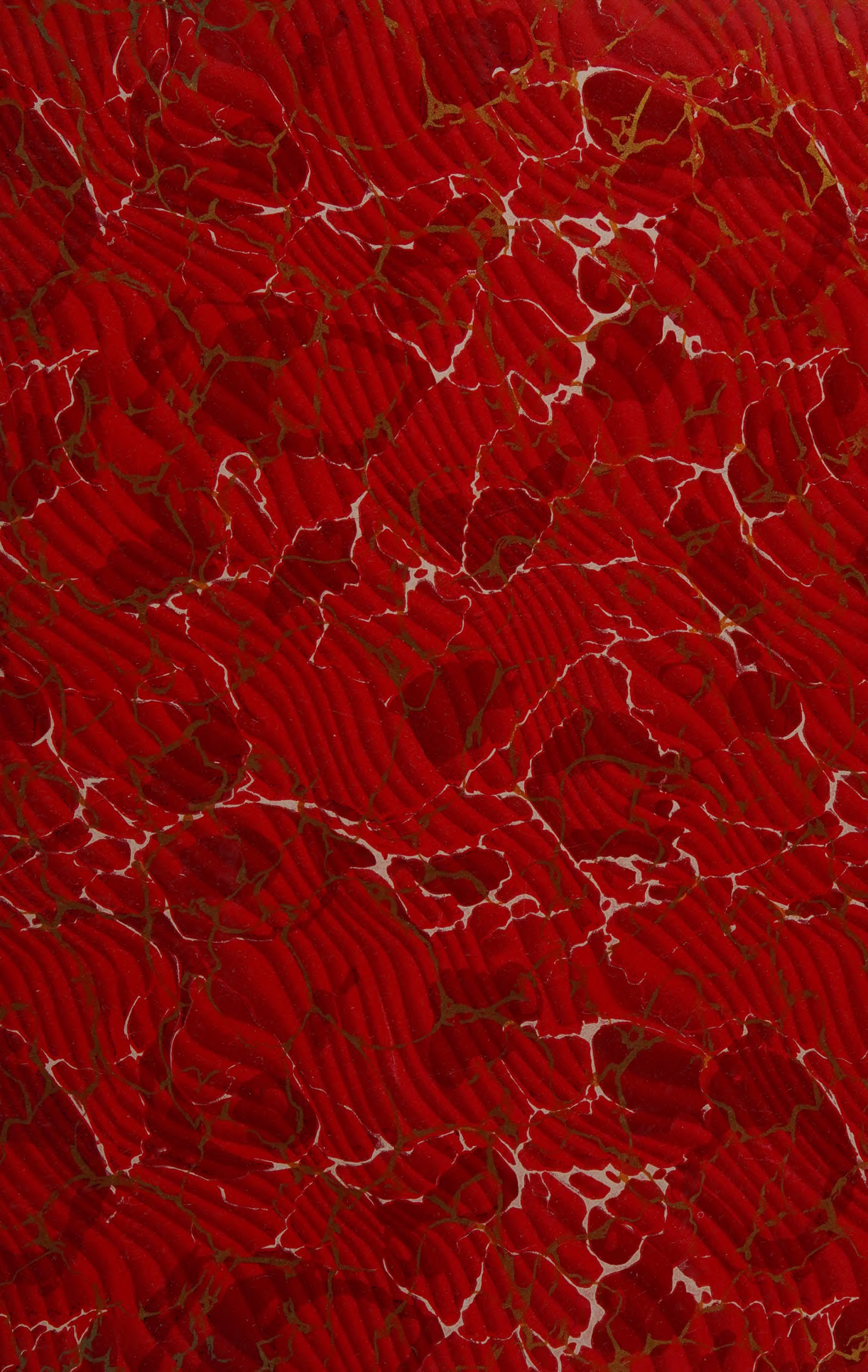


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THE ROYAL NATURAL HISTORY

VOL. V



REPTILES

CHAPTER I

GENERAL CHARACTERISTICS—CLASS *Reptilia*

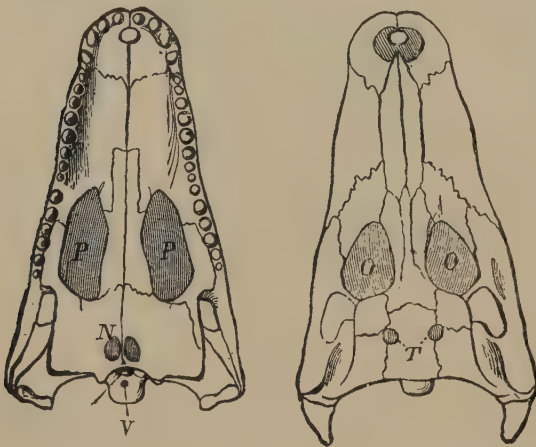
IN ORDINARY language the term Reptile is applied indifferently to such creatures as crocodiles, tortoises, lizards, snakes, frogs, and salamanders, but by the naturalist it is used in a more restricted sense, and includes only the first four of these, together with a host of extinct types; while the frogs and salamanders, with certain other forms, both living and extinct, on account of important structural differences, constitute a class by themselves, known as the Amphibians, and bearing the same rank as the class of Reptiles. To an ordinary observer there would seem but little in common between a scaled lizard or snake, a cuirassed

(2357)

crocodile, and a carapaced tortoise, on the one hand, and a feathered bird on the other. Nevertheless, as we have had occasion to mention at the close of the preceding volume, the connection between Reptiles and Birds is exceedingly intimate,—so close, indeed, that Professor Huxley has termed the latter greatly modified Reptiles. At the present day the two groups are, indeed, somewhat widely sundered; and it is only by the study of forms long since extinct that we are enabled to grasp the intimate relationship that exists between them. That Birds are the descendants of Reptiles may accordingly be taken for granted, although we are still unacquainted with the immediate links connecting the two classes. In another direction Reptiles are, however, connected through other extinct forms with the Amphibians; while from these intermediate, half-Reptiles, half-Amphibian creatures, it is probable, as elsewhere mentioned, that Mammals have originated. As we shall point out later on, Amphibians are also intimately connected with the class of Fishes, and we thus see how closely allied are all the classes of the Vertebrates, and how difficult is the task of the naturalist to distinguish them satisfactorily one from another when the whole of the extinct forms are taken into consideration. It is, indeed, solely from the still imperfect condition of our knowledge of the past that we are enabled to formulate any definitions at

all, for had we the whole chain of organized nature before us, it will be obvious that no breaks would exist, but that every group would pass by imperceptible degrees into the earlier one from which it originated.

Proceeding to the consideration of what constitutes a Reptile, as distinct from any other animal, we may first point out some of the features in which Reptiles agree with Birds, and thereby differ from Mammals. In the first place, the skull articulates with the first vertebra by a single knob, or condyle (*V* of the figure); while each half of the lower jaw is composed of several distinct bones; and the whole lower jaw articulates with the skull by the



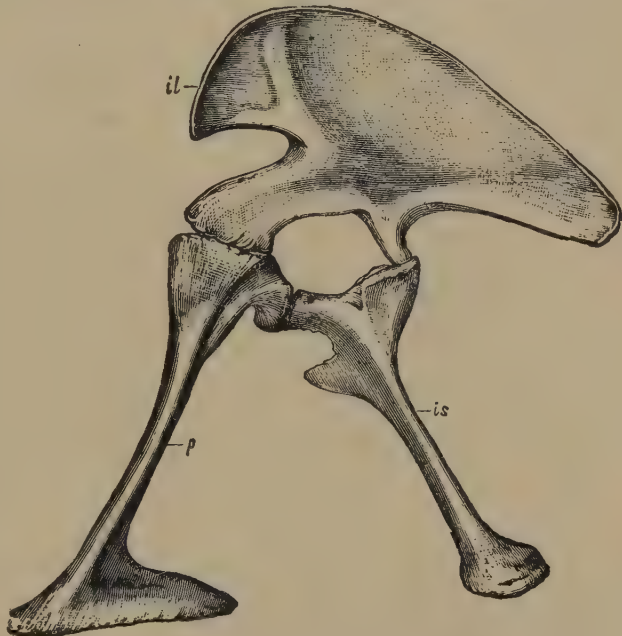
LOWER AND UPPER SURFACES OF THE SKULL
OF A CROCODILE.

N. aperture of the internal or posterior nostrils; *O.* sockets of the eyes; *P.* vacuities of the palate; *T.* frontal vacuities or fossæ; *V.* condyle of the occiput.

intervention of a separate quadrate bone.* Then, again, both agree in that the appendages developed from the outer layer of the skin never take the form of hairs, while the young are not nourished by means of milk secreted by special glands on the body of the female parent, neither are gills developed at any period of life, throughout which respiration is effected by means of lungs. A further resemblance is shown in the position of the ankle joint between the upper and lower

*In the figure the quadrate bones are the prominences at the hinder external angles on either side of the letter *N*.

rows of small bones entering into the composition of that part of the skeleton. In producing their young from eggs (sometimes retained within the body of the parent until hatched), Reptiles resemble not only Birds, but likewise the lowest Mammals; with which they also agree in the nature of the investments surrounding the embryo. As regards the distinction between the two groups, Reptiles are broadly separated from Birds by the absence of feathers; the appendages of the outer layer of the skin being in the form either of overlapping horny scales or of large shields uniting by their opposed edges. Moreover, all known Reptiles differ from Birds in having more than three digits in the fore-limb; while in no cases are the collar bones fused into a furcula, as they are in all flying Birds. A further distinction is to be found in connection with the circulatory system, the blood of all existing Reptiles being cold, while the aorta, or great propelling blood vessel of the heart is double, and crosses both branches (instead of only the left branch) of the windpipe. It will be obvious, however, that these two last characteristics cannot be verified in the case of extinct Reptiles, among which it is quite probable that there may have been some in which the blood was warm. A similar remark will apply to the absence among living Reptiles of those ramifications of the bronchial tubes throughout the body, which form such a characteristic feature in the structure of Birds. As additional features in the skeleton, it may be noticed that Reptiles never have the terminal faces of the vertebræ saddle shaped; while in those forms



THE BONES OF THE LEFT SIDE OF THE PELVIS OF AN
EXTINCT DINOSAURIAN REPTILE.

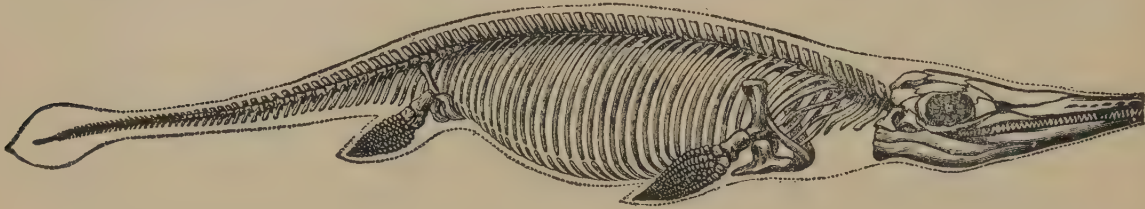
(One-twelfth natural size.)

il. ilium; *p.* pubis; *is.* ischium.—After Marsh.

in which the number of toes in the hind-limb is reduced to three, the metatarsal bones do not unite to form a canon bone in conjunction with the lower row of bones belonging to the ankle joint. Then, again, with the exception of one remarkable extinct group, Reptiles, as a rule, are characterized by the three bones of the pelvis remaining distinct from one another through life; whereas in all existing birds they are welded together. There are likewise differences in regard to the form and structure of the breastbone and sacrum, into the consideration of which it will be unnecessary to enter in this work.

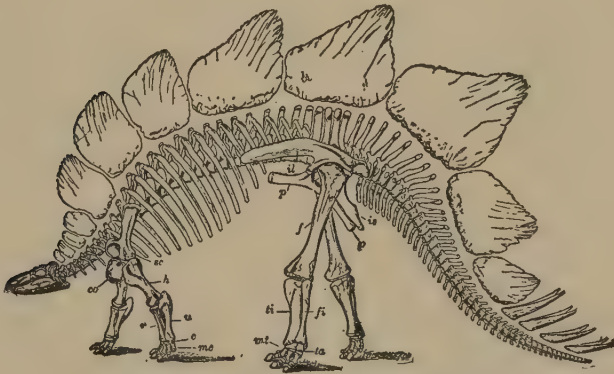
**Diversity of
Form and
Structure**

In marked contrast to the uniformity in appearance and structure characterizing Birds, the various groups of Reptiles differ widely from one another, both as regards external form and internal structure. Externally, a lizard, a snake, and a tortoise present the most marked differences in general appearance among living members of the order; while among extinct types there were some which walked on their hind-limbs alone, after the manner of Birds, and others having their fore-limbs modified into wings and the digits connected by a leathery membrane like that of bats. In a typical Reptile, such as a lizard or crocodile, both pairs of limbs are well developed, and of approxi-



SKELETON OF FISH LIZARD OR ICHTHYOSAUR.

mately equal length, but in the snakes all external traces of limbs have disappeared; while in the extinct flying dragons, or Pterodactyles, the fore-limbs much exceed the hind ones in size, and in many of the so-called Dinosaurs, which are likewise extinct, the excess in size falls to the share of the hinder pair of limbs. In other cases, again, the limbs may be modified into paddles, adapted for progression in the water, as in the existing turtles, and the extinct fish lizards or Ichthyosaurs; the body in the latter assuming a somewhat fish-like form. In nearly all cases Reptiles have long and well-developed tails; although in some of the flying dragons these become rudimentary.



RESTORED SKELETON OF ARMORED DINOSAUR.
(About one-sixtieth natural size.)

sc. shoulder blade or scapula; co. coracoid; h. upper arm bone or humerus; r, u. bones of fore-arm or radius and ulna; c. wrist or carpus; mc. metacarpus; il. haunch bone or ilium; p. pubis; is. ischium; f. thigh bone or femur; ti, fi. bones of lower leg or tibia and fibula; ta. ankle or tarsus; mt. metatarsus.—After Marsh.

A large number of Reptiles are characterized by the development of bony plates within the deep layer of the skin; such plates, which are well displayed in existing crocodiles, being overlain by horny shields, and thus corresponding in every respect with those forming the carapaces of the armadillos among Mammals. Among certain extinct Dinosaurs these bony plates attain a development unparalleled at the present

day, and in some they are believed to have occupied the extraordinary position shown in the figure on the preceding page.

Still more remarkable differences exist with regard to the form and structure of the teeth; which, instead of being, as in the two preceding classes, strictly confined to the borders of the jaws, may be spread over the entire palate. In spite, however, of this diversity of form, the teeth of Reptiles differ from many of those of the majority of Mammals in that they are never implanted in the jaws by two or more roots; while in no cases are their crowns complicated by the presence of infoldings of enamel. The simplest type of reptilian tooth is in the form of a cone; such conical teeth being confined to the margins of the jaws, where, as among crocodiles, they may be implanted in distinct sockets, or, as in the extinct fish lizards, in an open groove. In other cases, as among lizards, teeth of the same general type may be united by a bony deposit either to the summit or to one side of the margin of the jaw. In place of the one regular replacement, characterizing the anterior teeth of the majority of Mammals, the teeth of most Reptiles are replaced irregularly and continuously throughout life; the successional teeth growing up beneath the bases



CONICAL TOOTH OF AN
EXTINCT PLESIOSAU-
RIAN REPTILE.

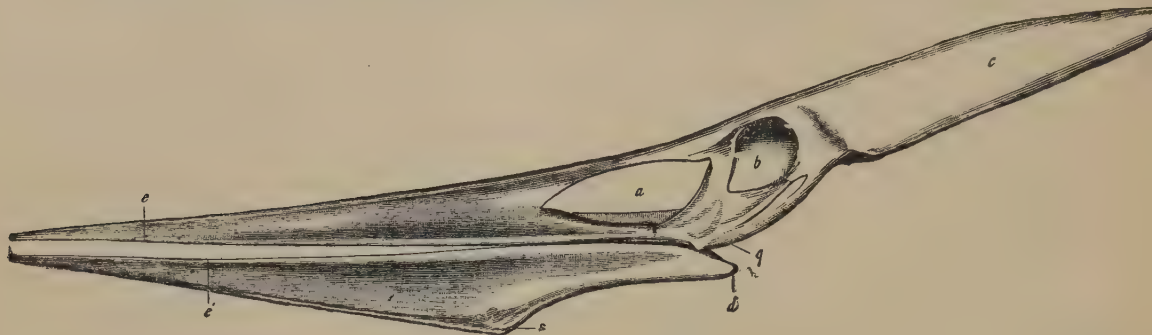


UNDER SURFACE OF SKULL OF AN
EXTINCT REPTILE (*Cyamodus*) WITH
PAVEMENT-LIKE TEETH ON THE
PALATE.

of those in use, and gradually causing an absorption of their roots. When teeth are distributed over the whole or a greater portion of the palate, they generally assume a more or less flattened and bean-like shape, so as to form a kind of pavement in the mouth, as shown in the accompanying figure of the under surface of the skull of an extinct reptile. Between conical and pavement-like teeth there are various intermediate grades, some of which will be referred to in the sequel. It is, however, by no means all members of the class that are provided with teeth; the tortoises and turtles being living examples of the total loss of these organs, and the consequent conversion of the jaws into horn-clad beaks. Certain representatives of the extinct flying dragons were likewise devoid of teeth, and as in these forms the horn-covered jaws were long and narrow, the resemblance to the beak of a bird becomes most marked.

It has already been stated that the vertebræ of Reptiles never articulate by means of those saddle-shaped surfaces so characteristic of Birds. They present, however, great diversity of structure in this respect. In some cases, for instance, as in the fish lizards, the bodies or central portions of the vertebræ are very short

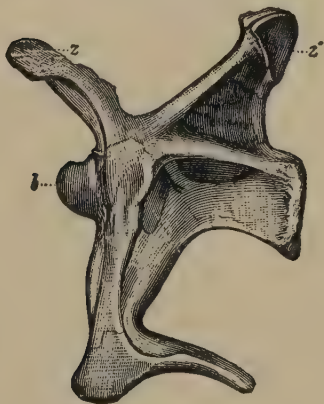
from front to back, and have concave surfaces both in front and behind for mutual articulation. In marked contrast to this type is the neck vertebra of a Dinosaur, where the anterior end of the body of each vertebra forms a convex knob (*b*),



LEFT SIDE OF THE SKULL OF A BEAKED FLYING DRAGON.
(One-sixth natural size.)

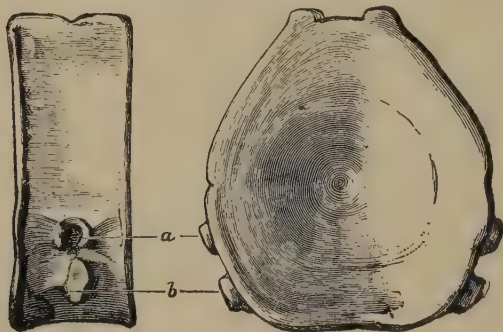
a. vacuity in front of the eye; *b.* socket of the eye; *c.* occipital spine; *d.* angle of lower jaw; *e.* extremity of upper, and *f.* of lower jaw; *g.* articulation of the skull proper with the lower jaw; *s.* point where the two branches of the lower jaw diverge.—After Marsh.

received into a cup at the posterior end of the vertebra in advance.* In other instances, as in the existing crocodiles and lizards, an arrangement precisely the reverse of the last is present, that is to say, the ball is at the hinder end, and the cup at the front of the body of the vertebra. In a few lizards and in all snakes the vertebræ are further complicated by the develop-



LEFT SIDE VIEW OF A NECK VERTEBRA
OF A DINOSAUR.

b. anterior ball.—After Marsh.



SIDE AND FRONT VIEWS OF THE BODY OF A
VERTEBRA OF A FISH LIZARD.

a. *b.* attachment of ribs.

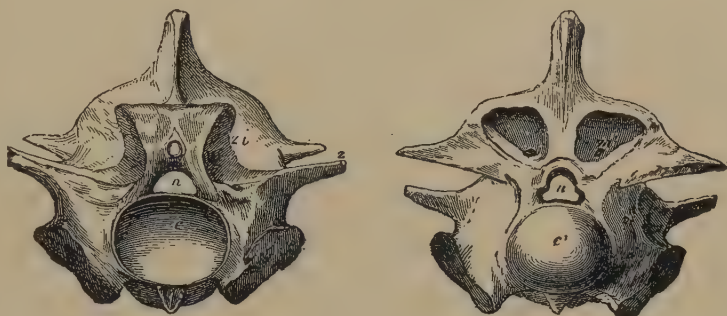
ment of additional articular facets, taking the form of wedge-like projections from one vertebra, which are received into cavern-like excavations in the adjacent one.

Omitting mention of certain features connected with their osteology, it may be observed that among those reptiles with four or five toes to each foot, while a few,

* It should be mentioned that in this figure only the portion of which *b* is the extremity corresponds with the whole of the specimen represented in the other figure on the same line.

such as certain tortoises, have the same number of joints in each toe as Mammals, —that is to say, two in the first toe, and three in each of the others,—in the greater majority there is a departure from this simple arrangement. In the lizards, for instance, the number of joints in the toes (reckoning from the first to the fifth digit) is 2, 3, 4, 5, 3 in the fore-limb, and 2, 3, 4, 5, 4 in the hind-limb; while in crocodiles, where there are but four toes in the latter, the numbers are respectively 2, 3, 4, 4, 3, and 2, 3, 4, 4. In this increasing number of joints in the toes from the first to the fourth, such reptiles approximate to birds.

As regards their soft internal parts, Reptiles are characterized by the low development of their brains, which, in conjunction with their cold blood, accounts for the generally sluggish movements of their existing representatives. With the exception of the crocodiles, Reptiles differ from Birds in that the heart has only three, in place of four, complete chambers, thus causing the freshly oxygenated blood returning from the lungs to be mixed with the effete blood which has trav-



FRONT AND BACK VIEWS OF A VERTEBRA OF A SNAKE.

zi indicates the additional articular process which is received into the cavity *zi'*.

ersed the body. Even in crocodiles, where the heart has practically four chambers, the fresh and effete blood is partially mingled, owing to a communication between the vessels just outside the heart. Like Birds, Reptiles never have a midriff completely separating the cavity of the chest from that of the abdomen.

Classification and Dis- tribution

Reptiles having come into existence at an earlier period than either Mammals or Birds; and attaining an enormous development during epochs when both those groups were but feebly represented, it would be only natural to expect that they should have suffered to a much greater extent by the extinction of types with the lapse of time. As a matter of fact this is found to be the case; the number of existing orders of Reptiles being now but four (of which one is represented by only one or two species), whereas, if we include the extinct types, at least nine orders may be recognized. These nine orders, of which the extinct ones are indicated by asterisks (*) may be named and arranged as follows, *viz.*:—

1. CROCODILES — Crocodilia.
- *2. DINOSAURS — Dinosauria.
- *3. FLYING DRAGONS — Ornithosauria.
4. TORTOISES and TURTLES — Chelonia.
- *5. PLESIOSAURIANS — Plesiosauria.

6. LIZARDS and SNAKES — Squamata.
- *7. FISH LIZARDS — Ichthyosauria.
8. TUATERAS or BEAKED LIZARDS — Rhynchocephalia.
- *9. MAMMAL-LIKE REPTILES — Anomodontia.

Of these groups, by far the most numerous represented at the present day is the one containing the lizards and snakes, all of which are highly specialized forms, occupying a position in the class analogous to that held by the perching birds in the preceding class, the majority being comparatively-small or medium-sized forms. Next in point of numbers come the tortoises and turtles, all of which are protected by the presence of a bony carapace, and some of which attain very large dimensions. The third numerical position in the fauna of the present day is held by the crocodiles, of which there are some twenty-four species, all of relatively-large size, and all more or less aquatic in their habits. The fourth existing order is now represented only by the lizard-like New Zealand tuateras, of which there is probably but a single species, although in past times there were a host of allied forms. Of the five extinct orders the whole or nearly the whole, of their representatives ceased to exist with the close of the Secondary period, that is to say, soon after the deposition of the chalk, and previous to that of the overlying London clay. During that long period, or "world of reptiles," the class attained a development which it never equaled before or since. The Dinosaurs, which were by far the largest of all land animals, then filled the place now occupied by Mammals; the flying dragons played the rôle of the bats and birds of the present day; while the marine Plesiosaurs and fish lizards did duty for whales and porpoises. Of the mammal-like Reptiles, it will suffice to speak in the sequel. With regard to the past distribution of the four existing orders, it may be mentioned that the lizards and snakes, with the exception of two extinct suborders, are practically unknown before the commencement of the Tertiary period — that is to say, until after the deposition of the Chalk; hence they may be regarded as essentially the Reptiles of the present day, when they attain their maximum development. The tortoises and turtles, although a much more ancient group, having existed throughout the Secondary period, are, however, still at or about their zenith. The case is, however, very different with the crocodiles, which were represented during the Secondary period by a host of forms quite unlike those of the present day, and probably more numerous in species than their existing representatives. Many of the extinct crocodiles also exceeded any of the living forms in point of size. Still more markedly is this diminution noticeable in the case of the tuateras, in which a solitary survivor represents a once abundant group.

Owing to the exigencies of space, our remarks on the present distribution of the class must necessarily be brief. In the first place, it may be observed that while no existing Reptiles are denizens of the air, only the turtles and sea snakes are habitual inhabitants of the ocean. Of the terrestrial and fresh-water forms, it has been found that the distribution does not coincide very closely with that of Mammals and Birds, so that the zoological regions into which the globe has been mapped out from the geographical distribution of the latter scarcely hold good for

Reptiles. This discrepancy may, no doubt, be partly explained by the very early period at which certain groups of the class, such as crocodiles and tortoises, spread themselves over the surface of the globe. As regards the dispersive powers of Reptiles in general, these according to Dr. Günther, are but limited. All these creatures, he writes, "are much specialized in their mode of life and propagation, and ill-adapted to accommodate themselves to a change of external condition. As air-breathing, cold-blooded animals they are unable to withstand prolonged cold; they are therefore entirely absent in the Arctic and Antarctic zones; and such as escape the effects of the winter months in temperate zones by passing them in a torpid condition in well-sheltered places are not peculiarly organized forms, but offshoots from those inhabiting warmer climes. The tropical and subtropical zones are the real homes of the reptilian type, which there has reached its greatest development as regards size and variety of forms. In the north, Chelonians advance only to 50° latitude in the Western and to 56° in the Eastern Hemisphere; lizards to about 56° in British Columbia, and close to the Arctic Circle in Europe; while snakes disappear some degrees before the lizards. Also in the south, lizards extend into higher latitudes than snakes, namely, to the straits of Magellan, while the latter do not seem to have advanced beyond 40° south latitude, and Chelonians to 36°."

Of the various zoological regions into which the globe has been divided, the Oriental or Indian region, according to the same observer, is characterized by the number of fresh-water soft tortoises* and S-necked tortoises,* land tortoises being scarce. Crocodiles, inclusive of the characteristic long-necked garials, are numerous, as are lizards and snakes—especially pythons. Africa has comparatively few Reptiles, although characterized by its numerous land tortoises, soft tortoises, and side-necked tortoises,* the crocodiles being represented only by members of the typical genus; while lizards and snakes are comparatively numerous. Among the lizards, monitors, and among the snakes, pythons, are common to the Oriental and African regions; while half of the exclusively Old-World group of chameleons are African. Madagascar is even more remarkable for the number of its chameleons; its land and side-necked tortoises are numerous, although soft tortoises, as in South America, are absent; there is one crocodile; and among the lizards the South-American group of iguanas is abundant; while the snakes, among which none is poisonous, are also of a South-American type. In the warmer parts of the Euro-Asiatic region (exclusive of India, etc.) the reptile fauna is mainly a mixture of Oriental and African types, although there are some peculiar forms. The only non-American alligator inhabits Central China. In the Australian or tropical Pacific region, exclusive of New Zealand, we meet with one group of land tortoises, side-necked tortoises, and a crocodile; while among the lizards there are skinks, geckos, monitors, and the so-called agamoids; the latter occurring in all the regions above mentioned, except Madagascar. Venomous snakes here outnumber the harmless ones. The Tropical and South-American region is characterized by the presence of land and side-necked tortoises, to the exclusion of soft tortoises. Crocodiles and caimans are numerous (the latter being characteristic); while of the

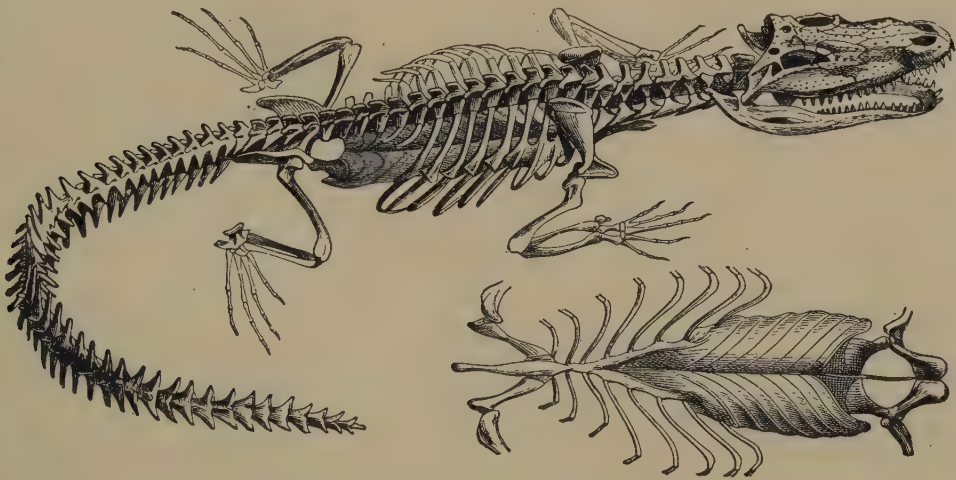
*For the explanation of these and other names, the reader must refer to later chapters.

abundant lizards the majority are iguanas, the true lizards (*Lacertidæ*) of the Old World being replaced by the teiias (*Teiidæ*); snakes are also numerous, among them being rattlesnakes and boas. In the North-American region there are no caimans, their place being taken by an alligator; while fresh-water S-necked tortoises, as well as soft tortoises, replace the side-necked tortoises of the southern half of the continent. The snapping tortoises (*Chelydridæ*) are also mainly characteristic of this region, although one genus ranges as far south as Ecuador. As regards its lizards and snakes, this region presents the same relation to the preceding as is held by Euro-Asia to the Oriental and African regions. Lastly, New Zealand stands apart from all other countries in possessing the remarkable tuatera, in addition to which its only reptiles are skinks and geckos.

CHAPTER II

CROCODILES, DINOSAURS, AND FLYING DRAGONS—ORDERS CROCODILIA, DINOSAURIA, AND ORNITHOSAURIA

THE living crocodiles, among which may be included in the general sense not only the reptiles to which that name more properly belongs, but likewise those commonly designated alligators, caimans, and garials, are the only existing representatives of three orders, which comprise among their members not only the most highly organized of all Reptiles, and those which approach nearest in their organization to Birds, but likewise the largest of all terrestrial Reptiles, as, indeed, of any land animals. Although these three orders possess many characteristics in common, it will be more convenient to describe the leading features of each separately, in the course of which their common attributes will be pointed out.



SKELETON AND ABDOMINAL RIBS OF CROCODILE.

Characteristics of Crocodiles Sluggish in disposition, hideous in form, and huge in size, crocodiles alone among existing Reptiles serve in some measure to recall the giant Saurians with which the earth was peopled during earlier periods of its existence. In addition to their large bodily size, crocodiles are characterized by the lizard-like form of their bodies, which are supported on short limbs, and carried close to the ground. The long and powerful tail is much compressed from side to side, so as to be an efficient propeller in swimming; its superficial extent being increased by a vertical longitudinal crest on its upper surface, this crest being formed of a double series of horny lobes in the basal half of the tail,



beyond which it is single. The head terminates in a flattened snout of variable length, and is attached to the body by a short, although muscular neck, while the bulky body is much depressed. The toes are more or less webbed. Externally the back, tail, and under parts of these animals are protected by an armor of quadrangular horny shields of varying size, which are arranged in regular longitudinal and transverse rows, and are in contact with one another by their edges. In the region of the back, and sometimes also on the under surface of the body, these horny shields are underlain by a corresponding series of pitted bony plates. In the region of the neck, among existing members of the order, these bony plates are often irregular in form, and vary in number, but on the back they are always quadrangular and broader than long, with a well-marked longitudinal ridge down the middle. Such plates form a considerable number of longitudinal rows; each plate articulating by its edges with those on either side, while those of each transverse row overlap those immediately behind them. When a bony shield is developed on the under surface of the body, the number of longitudinal rows of plates in existing forms is always more than eight; the transverse rows of plates overlapping and each plate being composed of two distinct pieces united by suture. The limbs are provided with five toes in front and four behind; the three innermost digits in each foot being furnished with claws. In all crocodiles, whether living or extinct, the conical teeth, which may be of very large size, are confined to the margins of the jaws, where they are implanted in distinct sockets; while those in use are continually being replaced by fresh ones growing from beneath. These animals are further characterized by their nostrils opening at the extremity of the snout—which may be either short or long—and by their ears being covered with movable lids.

Such are some of the leading external features of these reptiles, and although they would suffice to distinguish them from the living members of the order, they are insufficient to determine their true affinities. Laying stress upon the above-mentioned characteristics of their teeth, the naturalist is accordingly compelled to resort to the skeleton and soft internal parts for more distinctive characteristics. In the skull all crocodiles are characterized by the quadrate bone (of which the position is indicated in the figure on p. 2358) being firmly united with the adjoining bones; while a further distinctive feature is to be found in the presence of two bony bars on the sides of the skull behind the socket for the eye, the uppermost of these arches being shown immediately below the letter *T* in the accompanying



SIDE VIEW OF SKULL OF EXTINCT CROCODILE (*Pelagosaurus*).

O. socket for the eye; T. temporal pit or fossa.

figure, while the lower and more slender one forms the backward continuation of the inferior margin of the eye socket. The more anterior ribs (which as in other Reptiles, are present in the neck as well as in the chest) generally articulate with the backbone by means of two distinct heads; and, while collar bones are wanting, there is a breastbone and likewise an interclavicle; the

latter being the median bar seen in the lower figure of the illustration on p. 2367. A further peculiarity is the presence of seven or eight pairs of abdominal ribs in the wall of the abdomen, which have no connection with the proper ribs, and have their angle of union directed forward.* As regards the soft parts, the heart differs from that of all other living Reptiles in having four complete chambers, so that the fresh and impure blood can only mingle by means of a communication between the great vessels externally to the heart, while there is also an incomplete midriff dividing the chest from the abdomen.

In addition to the preceding characteristics, which are common to all members of the order, there are certain others found only in the existing forms and some of their nearest extinct allies. One of the most remarkable of these peculiarities is the extremely backward position of the aperture of the internal nostrils, which in the dried skull, as shown on p. 2358, is situated close up to the occiput, this being due to the development of special plates by the bones of the palate, which grow beneath the nasal passage, so as to form a floor to it, and thus completely cut it off from the cavity of the mouth. As the summit of the windpipe is continued upward into this posterior aperture of the nostrils, crocodiles are enabled to breathe while their mouths are wide open and filled with water. Another distinctive feature of the group, also shown in the figure just referred to, is that the socket for the eye communicates freely behind with the lower temporal fossa. Then, again, all existing members of the order are characterized by the bodies of the vertabræ having the ball behind and the cup in front; while the ribs of the chest are provided with hook-like or uncinatè processes resembling those of birds. In the region of the neck the ribs present the peculiarity of having backwardly projecting and overlapping processes, which effectually prevent these animals from turning their heads to one side.

Habits Crocodiles are denizens of the tropical and subtropical regions of the globe, and are found in such latitudes wherever there are rivers or fresh-water lakes of sufficient size for their mode of life; while one of the Indian species habitually resorts to the seacoast, where it has been seen floating at a considerable distance from the land. All of them are excellent swimmers, and are mainly propelled when in the water by the aid of their powerful tails; the limbs being chiefly used when walking at the bottom of the water, or on the shore. When in repose, crocodiles lie like logs either in the water or on the banks of the lakes or rivers they inhabit, but when in pursuit of their prey in the water they move with great speed, while they are also active on land. The young are, however, decidedly nimbler in their movements than are the adults. Exclusively carnivorous in the diet, some members of the order feed solely upon fish; while others, in addition to fish, prey upon the flesh of all animals that come in their way. Adult crocodiles, writes Dr. Günther, "attack every large animal which accidentally approaches them, and in overpowering it the whole of their powerful organization is called into requisition. Seizing the victim between their capacious jaws, and fastening their long pointed, conical teeth into its flesh, they draw it, in one mo-

* These abdominal ribs, connected together by the ligament, are shown in the figure before referred to.

ment, by their weight and with a stroke of the tail, below the water and drown it. Their gullet, is, however, much too narrow to allow of the passage of the entire body of the victim; and their teeth being adapted for seizing and holding fast only, and not for biting, they are obliged to mangle the carcass, tearing off single pieces by sudden strong jerks." This rending process is mainly accomplished by lateral movements of the head and front portion of the body. Too often, human beings, who incautiously bathe in crocodile-haunted waters, fall victims to these blood-thirsty reptiles; while there are instances of people being seized when merely stooping down to dip water from the river's marge. When seized, the only way for an unarmed man to escape is, it is said, to thrust his fingers into the creature's eyes and endeavor to gouge them out. To a considerable extent crocodiles are nocturnal in their habits, and during protracted droughts many of them at least are accustomed to bury themselves in the mud, where they become torpid.

As regards their reproduction, crocodiles lay from twenty to sixty eggs, of the approximate size of those of a goose, and invested with a hard, white shell. These are deposited in some hollow in the sand of the bank, where, after being covered to a greater or less depth, they are left to hatch. Whether the parent always assists in the incubation does not appear certain, although this has been proved to be the case in Madagascar by Dr. Voeltzkow. In that island the egg-laying season lasts from the end of August to the end of September; the usual number of eggs in a nest varying from twenty to thirty. The nest is excavated to a depth of about two feet in the dry white sand; its lateral walls being undermined so as to allow the eggs to roll into the cavities thus formed from the slightly elevated centre. Upon the summit of the completed nest, which is not noticeable externally, the parent sleeps; and when the young crocodiles are ready for hatching they utter distinct notes, which are heard by the mother even through a layer of two feet of sand. Digging down to the eggs, the parent crocodile lays them open to the air, upon which the young reptiles make their way out by perforating the shell at one extremity by the aid of a tooth specially developed for this purpose, the whole process occupying as much as a couple of hours. When hatched, the young crocodiles are led to the water by their parent, whose attention they attract by uttering cries, which are, however, of a lower pitch than those emitted while still in the egg.

EXISTING CROCODILES

Family *CROCODILIDÆ*

Caimans The whole of the existing members of the order are included in a single family, which may be subdivided into half a dozen generic groups. Of these, in some respects the most specialized are the caimans and alligators, which, although closely allied, are now generally regarded as belonging to distinct genera. Both caimans and alligators are characterized by their relatively-short, and broad snouts, in which the edges of the jaws are festooned,

and the nasal bones extend forward to the aperture of the nostrils,* while the two halves of the lower jaw are united in front by a very short bony union. The stout teeth vary considerably in size in different parts of the jaws; the third and ninth in the upper jaw, the fourth, and frequently also the first and eleventh, in the lower, being generally much larger than the others. In these features caimans and alligators resemble many of the true crocodiles; from which they are distinguished by the circumstance that, as a rule, both the first and the fourth tooth on each side of the lower jaw are received into pits in the upper jaw, so as to be invisible externally



SPECTACLED CAIMAN.
(One-fifteenth natural size.)

when the mouth is closed, while the upper teeth bite on the outer side of the lower ones. Moreover, the number of teeth varies from seventeen to twenty on each side of the upper jaw, and from seventeen to twenty-two in the lower jaw. Then, again, both these groups are characterized by the very small size of the upper temporal fossæ on the top of the skull, or those marked *T* in the figure on p. 2369; these fossæ being in some cases completely obliterated. Caimans are specially distinguished by the aperture of the nostrils not being divided in two by the nasal

*This is shown in the figure on p. 2358, where the nasals are the paired bones on the upper aspect of the skull, of which the narrow points just project into the cavity of the nostrils.

bones, by the presence of a strongly-developed bony armor on the inferior surface of the body, and by the bony plates on the upper surface being articulated together.

Caimans, or jacares, as they are called by the natives of Brazil, are restricted to Central and South America, where they are represented by five species. Of these, the largest, and at the same time the best known, is the black or great caiman (*Caiman niger*), from the rivers of tropical South America eastward of the Andes, which takes its name from the black of the upper surface of the body, the under parts being yellow. This species, which generally attains a length of about fourteen feet, is characterized by its partially bony and flat upper eyelid, by the presence of upper temporal fossæ in the skull, by the number of teeth in each premaxillary or anterior upper jawbone being five, and the number of lower teeth being seventeen or eighteen. Nearly allied, although of much smaller size, are the broad-nosed caiman (*C. latirostris*), ranging from the Amazon to the Rio de la Plata, and the spectacled caiman (*C. sclerops*), from Central and South America, both of which have the upper eyelid rugose, with a small horn-like projection, while in the skull the socket of the eye does not extend so far forward. Both are uniformly blackish when adult; but in the former the skull is very wide, and the number of lower teeth from seventeen to eighteen, while in the latter the skull is narrower, and the lower teeth vary from eighteen to twenty. The two remaining species (*C. trigonatus* and *C. palpebrosus*) are still smaller, and characterized by the color of the upper parts being yellowish brown, spotted and barred with black; while the upper eyelid is completely bony, the skull has no upper temporal fossa, there are but four teeth in each premaxillary bone, and the number of lower teeth is from twenty to twenty-two on each side.

On the Amazon and Orinoco, as well as other South-American rivers, caimans are to be met with in myriads, and appear to be very similar in their habits to the crocodiles of the Old World. Writing of the great caiman — jacare-uassu of the natives — Bates says that "it grows to a length of eighteen or twenty feet, and attains an enormous bulk. Like the turtles, the alligator [as he calls it] has its annual migrations, for it retreats to the interior pools and flooded forests in the dry season. During the months of high water, therefore, scarcely a single individual is to be seen in the main river. In the middle part of the Lower Amazon, about Obydos and Villa Nova, where many of the lakes with their channels of communication with the trunk stream dry up in the fine months, the alligator buries itself in the mud and becomes dormant, sleeping till the rainy season returns. On the Upper Amazon, where the dry season is never excessive, it has not this habit. It is scarcely exaggerating to say that the waters of the Solimóens are as well stocked with large alligators as a ditch in England is in summer with tadpoles." By the natives of these regions the caiman is at once despised and feared; the same traveler relating how on one occasion he saw a party boldly enter the water and pull to shore one of these large reptiles by its tail; while at another time two medium-sized specimens that had been captured in a net were coolly returned to the water hard by where a couple of children were playing. Sometimes, however, they have to pay dearly for such temerity. The Indians of Guiana, according to Water-

ton, capture the caiman by means of a baited hook and line, the former being composed of several pieces of wood, which become fixed in the creature's jaws. Waterton's account of his ride on the back of a caiman thus caught is probably familiar to many of our readers; and we have read of a similar feat being accomplished elsewhere. The eggs of the great caiman, which are about the size of those of a turkey, are said to be not unfrequently deposited in a heap of dry leaves, and are much sought after as food by the natives of Dutch Guiana.

The early Spanish settlers of South America on meeting with a gigantic lizard-like reptile naturally applied to it the name of *unlagarta*, which is the Spanish term for a lizard; and this as naturally became in course of time corrupted into alligator. It would appear, indeed, that this name was first given to the caiman, to which in strict propriety it should therefore belong; but now, by the common consent of naturalists, it is taken as the special designation of the members of the present genus. The alligators, as thus restricted, are represented by one species from North America, and by a second from the Yang-tse-Kiang in China; while there is also a third and imperfectly-known species, of which the inhabitat is as yet undetermined. The alligators differ from the caimans merely by the forward prolongation of the nasal bones of the skull, so as to divide the aperture of the nostrils into two equal moieties, by the want of articulation between the bony plates of the back, and the absence or extreme thinness of those on the lower surface of the body. Curiously enough, the Chinese alligator (*Alligator sinensis*), which is a comparatively small species, is the one coming nearest in structure to the caimans; this approximation being shown by the great development of bone in the upper eyelid, and the presence of thin bony plates on the lower surface of the body. The latter are, however, placed wide apart, without any mutual articulation or overlapping. In this species the front toes are free, the number of plates on the neck is usually six, although these may be reduced to four, while generally there are but six plates in the widest of the transverse rows on the back. The number of teeth in the upper jaw is seventeen or eighteen, against eighteen or nineteen in the lower. In color the upper parts are greenish black, speckled and streaked with yellow, while the under parts are grayish. In the much larger Mississippi alligator (*A. mississippiensis*), of which the dimensions exceed those of the great caiman, the front toes are webbed, there are but four plates on the neck, and there are always eight plates in the widest of the transverse rows of the back. There are nineteen or twenty teeth on each side of both jaws; and in the adult the color is dark green or blackish above, and yellowish below. The range of this species embraces the Southeastern United States, from the Rio Grande to North Carolina. The third species (*A. helois*) is a small one, distinguished by the slight compression of the tail, which is scarcely crested.

Our knowledge of the Chinese alligator (which was first made known to science in 1879) in the living state is mainly or entirely derived from specimens exhibited in the menageries of Europe; while the accounts of the mode of life of the Mississippi species are by no means so full as is desirable. It appears, however, that the latter spends the greater part of its time in the water, where its main diet is formed by fish, although it will seize and drag such sheep, goats, dogs, deer, or horses,

that, while drinking, come within reach of its terrible jaws. During flood time, when many of the lowlands are under water, the alligators leave the rivers to feed on the fish which abound in the flooded districts; returning to their old quarters with the subsidence of the inundations. To such flooded lowlands, writes Audubon, "in the early part of the autumn, when the heat of a southern sun has evaporated much of the water, the squatter, the hunter, the planter, all go in search of sport. The lakes then are about two feet deep, having a fine sandy bottom. . . . The



MISSISSIPPI ALLIGATOR.
(One-twentieth natural size.)

long, narrow Indian canoe, kept to hunt these lakes, and taken into them during the freshet, is soon launched; and the party seated in the bottom is paddled, or poled, to look for water game. Then, on a sudden, hundreds of alligators are seen dispersed all over the lake; their head and all the upper part of their body floating like a log, and in many instances so resembling one, that it requires to be accustomed to see them to know the distinction. Millions of the large wood ibis are seen wading through the water, muddling it up, and striking deadly blows with their bills on

the fish therein. . . . It is then that you see and hear the alligator at his work; each lake has a spot deeper than the rest, rendered so by these animals who work at it; and always situated at the lower end of the lake." By this means a supply of water is insured; and in these so-called alligators' holes the reptiles may be seen congregating in hundreds. "The fish, that are already dying by thousands through the insufferable heat and stench of the water, and the wounds of the different winged enemies constantly in pursuit of them, resort to the alligators' hole to receive refreshment, with a hope of finding security also, and follow down the little current flowing through the connecting sluices; but no! for, as the water recedes in the lake, they are here confined. The alligators thrash them, and devour them whenever they feel hungry, while the ibis destroys all that make toward the shore. By looking attentively on this spot, you plainly see the tails of the alligators moving to and fro, splashing, and now and then, when missing a fish, throwing it up in the air. The hunter marks one of the eyes of the largest alligators, and as the hair trigger is touched the alligator dies. Should the ball strike one inch astray from the eye, the animal flounces, rolls over and over, beating furiously about him with his tail, frightening all his companions, who sink immediately; while the fishes, like blades of burnished metal, leap in all directions out of the water, so terrified are they at this uproar."

During the pairing season, which takes place in the spring, the males resort to the land, and are but seldom seen; while soon after the female deposits her hard white eggs, which are said at times to be upward of one hundred in number. The nest in which the eggs are laid is generally placed among bushes or reeds, at a distance of fifty or sixty yards from the water's edge; the eggs themselves being carefully covered with leaves and other vegetable matter. The heat engendered by the decomposition of the latter, aids in the hatching of the eggs; and when the young appear, they are conducted to the water by the mother, who has all the time remained on guard near the nest.

In the middle and lower Tertiary deposits of both Europe and the United States, the present group was represented by certain extinct alligators (*Diplocynodon*) characterized by the presence of a bony armor on the lower surface of the body, coupled with the circumstance that the fourth tooth of the lower jaw was generally received into a notch in the side of the skull, while the third lower tooth was as much enlarged as the fourth. Some of these double-tusked alligators had short snouts, like their existing allies; but in one from the London Clay this part of the skull was much produced, as in many crocodiles.

A small and short-nosed crocodile (*Osteolemus tetraspis*) from West Africa, in the neighborhood of Sierra Leone, where it was discovered by Du Chaillu, presents much the same relationship to the true crocodiles as is held by the alligators to the caimans. Thus, while the arrangement of the teeth is similar to that obtaining in the true crocodiles, the nasal bones extend forward to divide the cavity of the nostrils into two halves. Moreover, the upper eyelid is largely bony, while there are detached bony plates on the lower surface of the body, as well as on the throat. The shield of the neck is distinct from that of

the back, and is composed of two or three pairs of plates, of which the anterior ones are very large; while that of the back comprises seventeen transverse rows of plates, the broadest row including six of such plates. The ridges on the plates of the neck are strongly marked, but they become very obscure in the two middle rows of the back. The fore-toes have only rudimentary webs, although those of the hind-limbs are webbed for about half their length. With the exception of parts of the head, tail, and back, which are light brown with black markings, the coloration of the adult is uniform blackish brown. Young specimens are, however, yellowish brown, spotted with black above, and with bars of the same on the body and tail; while the



STUMPY CROCODILE.
(One-twelfth natural size.)

lower armor is black and yellow. Practically nothing is known as to the habits of this peculiar species, which are, however, probably very similar to those of its allies.

True Crocodiles The true crocodiles comprise rather less than a dozen species, ranging over Africa, Southern Asia, Northern Australia, and Tropical America. Having no bony armor on the lower surface of the body, they are distinguished from the caimans and alligators by the interlocking of the upper and lower teeth, and by the fourth lower tooth being usually received into a

notch on the side of the upper jaw, so as to be partially visible when the mouth is closed, while the number of teeth varies from seventeen to nineteen on each side of the upper jaw, and fifteen in the lower. From the stumpy crocodile they are distinguished by the aperture of the nostrils in the skull not being divided by the forward prolongation of the nasal bones. While some of the species resemble the alligators in their broad and short snouts, others have elongated, narrow snouts, approaching those of the garials; but as there is an almost complete gradation from the one type to the other, this affords no ground for generic distinction, so that the most that can be done is to arrange them in groups.

Commonly known to the natives of India as the magar, and misnamed alligator by Anglo-Indians, the Indian crocodile (*Crocodilus palustris*) is the best-known representative of a group of four species which, in their broad and short snouts, make the nearest approach to the caimans and alligators. In all these the length of the snout does not exceed one and a half times its basal width; the bony union between the two branches of the lower jaw does not extend behind the level of the fourth or fifth tooth; while on the palate the line of union between the anterior and main jawbones (premaxillæ and maxillæ) extends nearly straight across the skull, as shown in the figure on p. 2358. The Indian crocodile has no bony ridges on the snout, while there are usually four longitudinal rows of bony plates on the back, and there are five teeth in each anterior upper jawbone or premaxilla. An allied species (*C. robustus*) from the interior of Madagascar, differs by having six longitudinal rows of plates on the back; while the Cuban crocodile (*C. rhombifer*), of Central America, and a nearly-related species (*C. moreleti*), from Guatemala, are distinguished by having a more or less distinct oblique ridge in front of the eye.

The habitat of the Indian crocodile includes India, Ceylon, Burma, and the Malay Peninsula and islands; its most westerly range being Sind and Baluchistan. Inhabiting rivers, lakes, and marshes, it appears to be an exclusively fresh-water species, never venturing into estuaries. As to the dimensions attained by this species, there is some uncertainty, although it is probable that at the present day specimens seldom grow to the size that was reached before firearms were common. Nowadays from twelve to fourteen feet appears to be a large size for this species, but a length of eighteen feet has been recorded, while skulls in the Calcutta Museum would seem to indicate still larger individuals. A nearly-allied extinct species has left its remains in the Siwalik hills of Northern India. Swarming in most of the rivers and marshes of India, except where the current is too swift, the Indian crocodile is stated to be less ferocious than the species next mentioned, generally preying on the smaller animals, and not unfrequently dragging down a wounded or dead bird before the eyes of the gunner. When the waters they frequent become dried up these crocodiles will either travel across country by night to another lake or river, or bury themselves in the mud.

Resembling its compatriot in its pale olive color, conspicuously spotted with black, the estuarine crocodile (*C. porosus*), of India and other regions, may be at once distinguished by its longer and more slender snout, as well as by the presence of only four teeth in each anterior jawbone

or premaxilla of the adult. It belongs, indeed, to a group of four species, differing from the preceding assemblage in the length of the snout varying from rather more than one and a half to just over twice its basal width; and also by the line of union between the anterior and main jawbones running in a V-shape up the palate. The presence of a large ridge running down the skull in front of the eye serves to distinguish this species not only from all the other members of the group, but likewise from the Indian crocodile. The present species generally, if not invariably, inhabits the tidal portions of rivers, from whence it descends into the sea, where it has



ESTUARINE CROCODILE.
(One-thirtieth natural size.)

been observed floating at considerable distances from land. These estuarine and partially marine habits will readily account for the wide geographical distribution of this crocodile, which ranges from India to Australia. Unknown on the western coast of India, the estuarine crocodile is abundant in the lower courses of the rivers of Bengal and other parts of the eastern side of India, as well as in Ceylon and Burma, whence it extends eastward to Southern China, Northern Australia, and the islands of the Solomon and Fiji groups. In point of size it probably surpasses

all other species, one specimen being recorded which reached the enormous length of thirty-three feet.

In correspondence with its gigantic size, this crocodile appears to be one of the most formidable members of its kind, being exceedingly prone to attack human beings, more especially in the breeding season, which takes place during June and July, when it is stated to attack such small boats as may cross its haunts. Owing to its depredations, these crocodiles are cordially detested as well as feared by the natives of India, and at Dacca, on the north of the Bay of Bengal, crocodile hunting is pursued as a profession. The following account of the pursuit of one of these monsters which had recently carried off a boy is abridged from a native newspaper. The hunter, having been summoned, moored his canoe hard by the place where the tragedy had taken place, it being well known that a crocodile which has been successful in securing a victim will generally remain for some days about the spot. Soon the crocodile was descried floating on the water, whereupon the hunter and assistant hid themselves in the canoe, while the son of the former entered the water, which he commenced to beat with his hands. Catching sight of the boy, the crocodile prepared to dive toward him, upon which the boy took refuge in the canoe. In a moment or so the reptile rose to the surface at the expected spot, where he was saluted with a couple of harpoons, one of which secured a firm hold. After a long chase, in which a number of the inhabitants



NILE CROCODILE.

of the village took part in boats, a second harpoon was safely planted in the head of the monster, who was finally dragged to shore. When opened, several gold and silver ornaments—the relics of earlier victims—were found in his stomach. In Ceylon, according to Sir J. E. Tennent, crocodiles are frequently captured by means of a hook and line, which are laid over night in the water, and made fast, in the native fashion, by a bunch of fine cords. These cords becoming fixed between the interstices of the creature's

teeth, are safe from being bitten through, and in the morning the captive is dragged ashore and dispatched. It may be added that when thus captured, crocodiles emit a disagreeable musky smell, due to the secretion of a pair of glands in the lower jaw.

Formerly inhabiting the Nile from its mouth to its source, the Nile crocodile (*C. niloticus*), from the invasion of its haunts by steam vessels and the introduction of rifles, has now well-nigh disappeared from Egypt, even as far back as the year 1870 being but rarely seen below Beni Hassan, and not

common till above the second cataract. In the upper reaches of the Nile it still exists in its pristine numbers, whence its range extends southward to the Cape and northward to Senegal. The species also occurs in Madagascar, while it likewise still lingers in Syria, in the neighborhood of the Zerka, or Crocodile river, near Cæsarea. Distinguished from the estuarine crocodile by the absence of the ridge in front of each eye, this species differs from the other two members of the same group by the want of any ridge on the middle of the snout or forehead, so that its whole skull is comparatively smooth. In size it falls but little, if at all short of the estuarine crocodile, although differing from the latter by the uniformly dark olive color of the adult.

As the habits of this crocodile do not differ in any important respects from those of the other members of the genus, they do not require any detailed notice, although a few words must be devoted to its cult by the ancient Egyptians, among whom it was known by the name of *champsä*. By these remarkable people the crocodile was regarded as the symbol of sunrise — possibly, it has been suggested, on account of the brightness of its eye, or perhaps, because that is the first part to appear when the creature emerges from the water. Among the places where the crocodile was specially revered were Thebes and the shores of Lake Moeris, as well as Ombi, near Syene. At Thebes a crocodile was reared from youth in the temple, where it was fed with sacred food, adorned with rings and bangles, and worshiped with divine honors; while after death its mummified body was carefully preserved in the catacombs, where hundreds of embalmed crocodiles are still to be found. Something analogous to this Egyptian veneration for the crocodile is to be met with in other countries. Leith-Adams tells us that the Indian crocodile is reclaimed by certain religious sects in India, being rendered so tame that it will leave its pond to feed out of its keeper's hand; while Mrs. R. B. Lee relates that at Dix Cove, on the northwestern coast of Africa, a pair of tame crocodiles were kept in a pond by priests, dressed in white garments, who fed their charges with snow-white fowls.

In the Upper Nile the favorite haunts of the crocodiles are sand banks, situated in parts of the river where the current is not too strong. There they may be seen at all hours of the day sleeping with widely-opened mouths, in and out of which the black-backed plover (as mentioned on p. 2253 of the preceding volume) walks with the utmost unconcern. According to Arab accounts, one and the same crocodile has been known to haunt a single sand bank throughout the term of a man's life; thus leading to the conclusion that these creatures must enjoy a long term of existence, during the whole of which they continue, like other reptiles, to increase in size. In common with this feature of uninterrupted growth, all crocodiles are also distinguished by their remarkable tenacity of life; the shots that prove instantaneously fatal being those that take effect either in the brain itself or in the spinal cord of the neck. It is true, indeed, that a shot through the shoulder will ultimately cause death; but it allows time for the animal to escape into the water, where its body immediately sinks. To reach the brain, the crocodile should be struck immediately behind the aperture of the ear. Although it is commonly supposed that the bony armor of these reptiles, is bullet-proof, this is quite erroneous; if the plates are struck obliquely, the bullet will, however, frequently ricochet.

A remarkable instance of boldness and ferocity displayed by a crocodile of this species is narrated by a correspondent of the *Times* during a journey to Mashonaland. On arriving one evening at the banks of the narrow but rocky Tokwi river, a man named Williams rode in with the intention of crossing. During the passage his horse was carried by the stream a few yards below the landing place, and just as he reached the opposite bank he was seized by the leg by a crocodile, which



SHARP-NOSED CROCODILE.
(One-thirtieth natural size.)

dragged him from his horse into the stream. There the reptile let go its hold, upon which the man managed to crawl on to a small island. Immediately his companion rode in to his assistance, upon which another very large crocodile mounted up between him and the horse's neck, and then slipped back, making a dreadful wound on his side and in the horse's neck with its claws as it did so. The river seemed, indeed, to be absolutely swarming with crocodiles; and it was with the greatest diffi-

culty that the unfortunate man Williams, who ultimately died of his wounds, was brought to the bank.

The Siamese crocodile (*C. siamensis*), inhabiting Siam, Cambodia, and Java, may be distinguished from the preceding species by the presence of a longitudinal ridge on the skull between the eyes, although the snout is smooth. It agrees with the latter in having the anterior bony plates of the neck well developed, these being usually absent in the estuarine crocodile.

The last member of this group is the sharp-nosed crocodile (*C. americanus*) of Central America, which has a longer and sharper muzzle than any of the preceding, and is further characterized by the presence of a distinct median ridge running down the snout. There are usually four large bony plates on the neck, forming a square, with a smaller pair on the sides of the front ones; while the plates of the back are arranged in fifteen or sixteen transverse rows, and in either four or six longitudinal bands. In the fore-limb the second and third toes are but slightly webbed, while the outer toes of the hind-foot are united by larger webs. In coloration the adult is blackish olive above, and yellowish beneath; while the young are pale olive with black spots. In addition to being widely distributed in Central America and the adjacent regions, such as Ecuador, Colombia, Venezuela, and Florida, this crocodile is also met with in the West-Indian islands.

Nearly allied to the last, although with a still longer and more slender snout, is the Orinoco crocodile (*C. intermedius*), which is referred by Mr. Boulenger to a third group, characterized by their very slender and garial-like snouts, of which the length is equal to at least twice the basal breadth; and also by the bony union between the two branches of the lower jaw extending as far back as the sixth, seventh, or eighth tooth, instead of stopping short at the fifth. In this particular species the snout, which has no ridges, varies in length from twice to twice and a half the width at the base; while the six bony plates on the neck are widely separated from those of the back, and are arranged in a square of four, with a pair on the sides. The color is olive above and yellowish beneath, while in both this and the preceding species the length is about thirteen feet. The Orinoco crocodile appears to be confined to the river from which it takes its name and its affluents. The best accounts of the Orinoco and sharp-nosed crocodile are by Humboldt, who states that these reptiles swarm on the Apure, where they may often be seen in parties of eight or ten lying on the open space between the shore of the river and the forest. At the time of his journey the river was, however, still low, and consequently hundreds of crocodiles were lying concealed beneath the mud of the adjacent lowlands. In the stomach of one that was opened were found a half-digested fish and a granite pebble; the latter having probably been swallowed inadvertently while the animal was groping about in the mud in search of food. In spite of their comparatively-slender jaws, these crocodiles frequently seize the natives while stooping to draw water from the river. A large portion of their prey is, however, afforded by the defenseless carpinchos, which are met with in droves of from fifty to sixty head, and fall victims to the jaguars on land and to the crocodiles in the water. In their young state — when

only from seven to eight inches in length — the crocodiles themselves are, however, devoured by vultures, who seize them on the shore or in the shallow water. It was curious, observes Humboldt, to see the address with which the little reptiles defended themselves for a time against their aggressors. As soon as they perceived the enemy, they raised themselves on their fore-paws, bent their backs, and lifted up their heads, opening their wide jaws. They turned continually, though slowly, toward their assailant to show him their teeth, which, even when the animal had but recently issued from the egg, were very long and sharp. Often, while the at-



LONG-NOSED CROCODILE.
(One-twentieth natural size.)

tention of one of the young crocodiles was wholly engaged by one of the vultures, another seized the favorable opportunity for an unforeseen attack, pouncing on the unfortunate reptile by the neck and bearing it off in the air. The anecdote told by Humboldt of a native of Calabozo being awakened in the middle of the night by one of these crocodiles suddenly breaking through the mud of the floor of his hut, beneath which it had retired for the dry season, is probably familiar to most of our readers.

Long-Nosed
Crocodile

Omitting notice of the small Johnston's crocodile (*C. johnstoni*), of North Australia, the last member of the genus is the curious long-nosed crocodile (*C. cataphractus*), of West Africa, which forms a kind of connecting link between the other true crocodiles and the garies. In this species the snout is more elongated and slender than in any of its congeners, its length not unfrequently exceeding three times its basal width; the bony union between the two branches of the lower jaw being likewise of unusual length. In form the snout is convex, and devoid of ridges; while the region of the forehead is remarkable for its convexity. The great peculiarity about the species is, however, to be found in the arrangement of the bony plates on the neck, which form two longitudinal rows, and are partially if not completely continuous with those of the back; a somewhat similar arrangement existing in Johnston's crocodile. On the back the number of longitudinal rows of shields is six; and the lower parts of the legs, as in many other crocodiles, are furnished with a jagged horny fringe. In color the head is olive spotted with brown; the back and tail have a brownish-yellow ground color, with large black spots, while the yellowish-white under parts are marked with smaller white spots. In length this species reaches some eighteen feet.

The long-snouted crocodile is found in the rivers and marshes of West Africa, from Senegambia to the Gabun, and also occurs farther to the south in the Congo, its native name being khinh. Not unfrequently found in company with the Nile crocodile, it inhabits the smaller streams and still waters of the interior, generally taking up its position in a deep pool protected by an overhanging bank or rock, and thence sallying forth on its prey, which consists chiefly of fish, frogs, and aquatic reptiles. The eggs are laid on the bank, where, unlike those of most other members of the family, they are carefully covered with leaves and herbage. Shy and timid in its disposition, this crocodile is often captured by the natives for the sake of its flesh; which, like that of many of its allies in other regions, is much esteemed as food. While very abundant in the fresh waters of the interior, this species likewise haunts the salt-water lagoons of the Guinea coast; and in the delta of the Cameroons may be observed lying on the sand banks bordering the mangrove swamps, from which, on the approach of a boat, it darts into the water with surprising celerity. There it often pulls down herons and such other aquatic birds as may be standing or swimming in the water, sailing up to them with the silence of a large fish, to which, when in the water, it presents a considerable resemblance. As in the estuarine and Nile crocodiles, in the adult of this species the second tooth in the fore jawbone, or premaxilla, disappears, leaving only four in place of the normal five on each side.

Schlegel's
Garial

With the very long and slender-snouted crocodile, from Borneo, commonly known as Schlegel's garial (*Rhynchosuchus schlegeli*), we come to the first of two genera, each represented by a single existing Oriental species, which differ very remarkably from any of those yet noticed. In both these forms the snout is long and slender, with its teeth-bearing margins nearly straight, instead of being thrown into more or less well-marked festoons; while the nasal bones never extend forward to reach the aperture of the nostrils,

from which they are separated by a considerable interval. Moreover, the bony union between the two branches of the lower jaw is of great length, extending at least as far back as the fifteenth tooth; and including a bone which in the other crocodiles remains entirely separate from the symphysis. In neither do the teeth attain the large dimensions characteristic of many other members of the family.

Schlegel's garial has the shorter snout of the two, its length not exceeding three and a half times its basal width; but it is especially distinguished by the circumstance that the nasal bones extend forward to articulate with the anterior jawbones, or premaxillæ. The teeth are twenty or twenty-one in number on each side of the upper jaw, and eighteen or nineteen in the lower; those on the sides of the latter being received in pits between the upper ones, and the first, fourth, and ninth lower teeth being enlarged. The bony plates on the neck and back form a continuous shield consisting of four longitudinal, and twenty-two transverse rows; and while the fore-toes are webbed at the base, the outer ones of the hind-feet have larger webs. In color, Schlegel's garial is olive above, with dark spots or bars; while its length may be twelve or fourteen feet. In habits this species is probably very similar to the Indian garial. It is important to notice that several fossil representatives of this genus occur in the Tertiary deposits of Europe, while it is not improbable that the genus is also represented in the underlying Cretaceous rocks. All this is exactly in harmony with what we should naturally have expected to be the case, seeing that Schlegel's garial, like the true garial, is evidently a very generalized member of the family.

Garial

Probably owing to a clerical error on the part of its first describer the slender-snouted crocodile known in India by the vernacular name of garial, is almost always spoken of in Europe as the gavial, while its misspelled name has even been Latinized into *Gavialis*—an error which some writers persist in perpetuating. The garial (*Garialis gangetica*) is readily distinguished at a glance from all other crocodiles by the exceeding length and slenderness of its snout; the length varying from more than five times the basal width in the young to rather more than three in the adult. This narrow snout gives to the reptile a decidedly curious appearance; and it is perhaps noteworthy that both the garial and the gangetic dolphin, which inhabit the same rivers, and probably feed on the same kind of food, have similarly-elongated beak-like snouts, armed with very similar curved and slender conical teeth; this resemblance being doubtless due to adaptation to a similar mode of life. From Schlegel's garial, the present species is readily distinguished by the nasal bones being very short, and consequently separated by a long interval from the anterior jawbones, or premaxillæ; while the teeth—twenty-seven to twenty-nine on each side of the upper, and twenty-five or twenty-six in the lower jaw—are all of nearly-uniform size, and those of the lower jaw are not received into distinct pits. Moreover, the bony union between the two branches of the lower jaw extends backward to the twenty-third or twenty-fourth tooth, whereas in the Bornean species it stops short at the fourteenth or fifteenth. At its extremity the long and narrow snout becomes much expanded; and in the male this expanded extremity is surmounted by a hollow hump, in the centre of which are placed the nostrils. The bony plates of the neck form a shield continuous with that of the back, in which

the number of longitudinal rows is four, while there are twenty-one or twenty-two transverse bands. Externally to the bony shields of the back there occurs on each side a row of soft plates, which are either smooth, or but slightly keeled. The toes are well webbed; and the general color of the adult is dark olive above; the young being pale olive, with dark brown spots or bars.



GANGETIC GARIAL.
(One-twenty-fifth natural size.)

The gharial has a somewhat curious geographical distribution, being restricted to the Indus, Ganges, and Brahmaputra, with their larger affluents, together with the Mahanadi in Orissa, and the Koladyne river in Arakan. Together with certain tortoises mentioned later on, this reptile is one of the most ancient of living animals, its fossil remains occurring in the rocks of the Siwalik hills in Northern India in association with those of mammals belonging to extinct species and genera. Attaining a length of fully twenty feet at the present day, and still larger dimen-

sions during the Pliocene period, the garial subsists solely upon fish, for the capture of which its elongated narrow jaws, armed with numerous long, curved teeth, are admirably adapted. There appears, indeed, to be no well authenticated instance of these reptiles having attacked human beings or the larger mammals; and it is perhaps owing to this harmless disposition that they are held sacred in many parts of India by the Hindus. In accordance with the nature of its prey, the garial seems to be more thoroughly aquatic in its habits than most of its allies; the relatively-long hind-limbs and the fully-webbed toes being features specially suited to aid in swimming. In the breeding season the female garial lays about forty eggs in the sand of the river bank, these being deposited in two layers, and covered to a considerable depth with sand; the two layers being probably laid on different days. The newly-hatched young, which, from the great proportionate length of their snouts, present a most extraordinary appearance, are very active, and of a grayish-brown color, with five irregular dark oblique bands on the body, and nine on the tail.

Extinct Garials In addition to those of the existing species, the Siwalik hills have yielded remains of several extinct garials, some of which attained gigantic dimensions; while other species belonging to the living genus have been obtained from the middle Tertiary rocks of England. Possibly, also, certain fossil garials from the Cretaceous deposits of the United States should find a place in the same generic group. Other Cretaceous species are, however, remarkable for the presence of a vacuity in the skull in front of the eye socket, in consequence of which they have been separated as a distinct genus, under the name of *Thoracosaurus*. Mention must also be made of an enormous garial from the Siwalik hills, known as *Rhamphosuchus*, which attained a length of some fifty or sixty feet, and had teeth as large as those of the biggest crocodile; its upper teeth biting on the outer side of the lower ones, instead of interlocking with them, as in the living form.

THE EARLIER CROCODILES

As already mentioned, all the existing crocodiles, together with the species from the Tertiary formations, constitute a single family, characterized by the vertebræ having a ball in front and a cup behind, and by the internal nostrils being situated at the hinder end of the skull; as well as by the bony plates of the back being arranged in at least four longitudinal rows. Although a few species found in the topmost beds of the underlying Secondary formations approximate in some respects to the foregoing, the majority of the crocodiles from rocks as old or older than the Chalk differ very considerably from the existing types. In the first place, the bodies of their vertebræ articulate with one another by slightly hollowed surfaces at both ends; while, owing to the want of union between the hindmost bones of the palate beneath the nasal passages, the internal apertures of the nostrils are situated nearly in the middle of the skull. Then again, when a bony armor is present, the plates on the back are arranged in only two longitudinal rows, while those

on the lower surface of the body form two distinct shields. It is remarkable that among these extinct crocodiles some are met with having broad and short snouts like the modern alligators, while others have long and narrow snouts like the garies. In the Wealden and Purbeck rocks, underlying the Chalk, some of these crocodiles, such as the short-snouted Swanage crocodile (*Goniopholis*), resembled living types in having the socket of the eye communicating freely with the lower temporal fossa, although they were distinguished by the plates of the back articulating by means of a peg-and-socket arrangement. In still older formations, such as the Lower Oölites and Lias, there were, however, many long-snouted crocodiles, such as the steneosaurs (*Steneosaurus*) and pelagosaurs (*Pelagosaurus*), in which the socket of the eye is divided from the lower temporal fossa by a bony bar, as shown in the figure on p. 2369. Moreover, in these forms the upper temporal fossa (*T* in the figure cited) was larger than the socket of the eye, whereas in all living forms the former is much the smaller of the two, and may even be obliterated. Another group of crocodiles,—the metriorhynchs (*Metriorhynchus*),—of the Oxford and Kimeridge Clays, were remarkable in having no bony armor at all, in which respect they were more specialized than any of their living cousins. In general, however, the earlier extinct crocodiles, as will be gathered from the foregoing remarks, were decidedly of a less specialized type than those of the present day; and as a gradual transition can be traced in these respects from the oldest to the most recent, the group affords a very interesting instance of progressive evolution. In the very oldest of the secondary rocks, namely, the Trias, there occur, both in Europe and India, certain very remarkable long-snouted reptiles, known as Parasuchians, which appear in some respects intermediate between crocodiles and tuateras. Thus, while they resembled the former in the nature of their teeth, bony armor, ribs, and vertebræ, they approximated to the latter in the structure of the skull, abdominal ribs, and probably of the collar bones and interclavicle.

THE EXTINCT DINOSAURS

Order DINOSAURIA

Nearly allied to crocodiles are those remarkable extinct reptiles from the rocks of the Secondary period, which include among their number the most gigantic of all land animals, and likewise those members of the reptilian class which make the nearest approximation in their organization to birds. During that epoch of the earth's history in which the Chalk and underlying Oölitic rocks were deposited, when mammals were represented by a few small forms of lowly type, these strange reptiles were the dominant animals on land; some progressing in the ordinary lizard-like manner, while others stalked on their hind-limbs like birds. To give some idea of the enormous dimensions attained by some of these creatures, it may be mentioned that the thigh bone of one species measures sixty-four inches, while the total length of its skeleton is estimated to have been between sixty and eighty

feet. On the other hand, some species were comparatively small, and not more than a couple of feet in length. Although the whole of these reptiles are markedly distinct from the crocodiles, yet they agree with them in the general characteristics of their skulls, vertebræ, and ribs; but they differ so decidedly from one another that it is not easy to give a definition of the entire order. They are, indeed, divided into three well-marked groups, with so many differences between them that in the



RESTORATION OF THE IGUANODON.

opinion of many they are entitled to rank as separate orders; and it will, accordingly, be most convenient to treat these three groups *seriatim*.

**Lizard-Footed
Group**

The most stupendous members of the order are included in a group which may be conveniently designated lizard-footed dinosaurs, on account of their walking in the ordinary lizard-like manner, and in having five toes to the feet. The most striking peculiarity of this group is to be found

in the circumstance that the vertebræ of the neck and back, as shown in the accompanying figure, had large cavities in their sides, which in the living state may have been filled either with cartilage or with air. These vertebræ resembled those of existing crocodiles, as described on p. 2361 in having a ball at one end and a cup at the other; but whereas in crocodiles the ball is at the hinder end of the body and the cup in front, in these dinosaurs precisely the reverse of this arrangement obtained. As regards their dentition, these reptiles had their teeth implanted in distinct sockets, like crocodiles; but the teeth themselves, as shown in the accompanying figure, were of a peculiar spatulate shape, with the outer side convex and the inner concave. Agreeing in the general structure of their pelvis with crocodiles, these



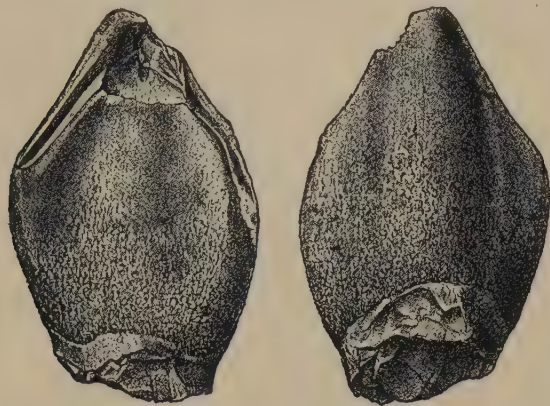
LEFT SIDE VIEW OF AN IMPERFECT VERTEBRA
OF A LIZARD-FOOTED DINOSAUR.

(From the *Quart. Journ. Geol. Soc.*, 1893.)

INNER AND LATERAL VIEWS OF A TOOTH
OF A HOPLOSAUR.

dinosaurs were distinguished therefrom by the circumstance that the bone known as the pubis (*p* in the figure on p. 2359) enters into the composition of the cavity for the reception of the head of the thigh bone. The limb bones are solid throughout. From the nature of their teeth, which are often much worn by use, it may be inferred that these reptiles were vegetable feeders; and it is not improbable that they frequented the margins of lakes and rivers, where their inordinately long necks would enable them to browse with ease on the various aquatic plants. That they must have been very sluggish in their movements and stupid in their ideas is indicated by the wonderfully small proportionate size of their brains. These dinosaurs were common both in Europe and the United States, the larger forms

having been described under the names of pelorosaurs (*Pelorosaurus*), atlantosaurs (*Atlantosaurus*), brontosaurus (*Brontosaurus*), and hoplosaurus (*Hoplosaurus*); among



INNER AND OUTER VIEWS OF A TOOTH OF A PELOROSAUR.

(From the *Quart. Journ. Geol. Soc.*, 1893.)

which the atlantosaurs appear to have been the most gigantic. They also occur in India, Argentina, and Madagascar.

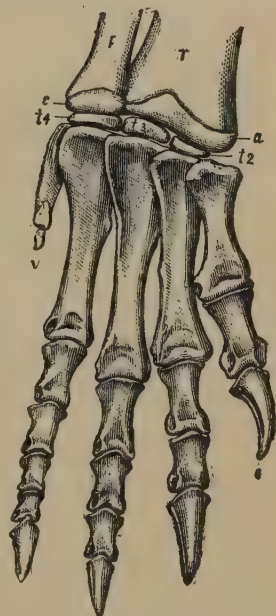
The carnivorous dinosaurs, of which the megalosaurus (*Megalosaurus*) is the best-known example, differed from the preceding group in the form of their teeth, which were compressed and sickle shaped, with sharp, cutting, and frequently serrated edges. Their limb bones also were hollow; while their vertebræ were likewise hollow internally, but had no lateral cavities; and the pelvis (figured on p. 2359), although of the same general type as in the lizard-footed group, presented important points of distinction. In place of the short feet of the last-named group, the carnivorous dinosaurs had elongated foot bones, terminating in sharp claws;



THE LEFT HUCKLE BONE AND LOWER END OF TIBIA OF THE MEGALOSAUR.

(After Gaudry.)

the number of functional toes in the hind-foot varying from four to three. That they habitually walked on the toes of their hind-limbs, and not (as was the case with the lizard-footed group) on the whole foot, is evident from the structure of this part of the skeleton, and from the circumstance that the fore-limbs were considerably smaller than the hinder pair, it may be inferred that progression was at least frequently accomplished by the aid of the latter alone. The close approximation of the huckle bone of the ankle to the lower end of the tibia foreshadows the complete amalgamation which takes place between those bones in birds; while in one remarkable American form the metatarsal bones of the foot were reduced to three in number, and had nearly the same relationship to one another and to the bones of the ankle as obtains in birds. While the megalosaurus attained a height, when erect, of some fifteen feet, the little Compsognathus, of the lithographic limestones of Bavaria, did not stand more than two feet; and there were other equally diminutive forms, both in England



BONES OF THE RIGHT HIND-FOOT OF A CARNIVOROUS DINOSAUR.

and the United States, in which the whole backbone was so permeated by air cavities as to be little more than a mere shell of bone.

The whole of the dinosaurs mentioned above agree with one another in possessing a pelvis approximating to the crocodilian type; that is to say, the pubis or anterior lower bone of this part of the skeleton is inclined downward and forward, and thus diverges in the form of an inverted *V* from the backwardly and downwardly directed ischium, or posterior lower bone, as shown

**The Bird-Like
Group**



SKELETON OF THE CLAOSAUR, ONE OF THE BIRD-LIKE DINOSAURS.
(One-fortieth natural size.)

(After Marsh.)

in the figure on p. 2359. On the other hand, in the bird-like dinosaurs the main bar of the pubis is inclined backward, parallel to the ischium, while it has a secondary plate projecting forward. In this parallelism of the pubis and ischium these dinosaurs resemble birds (see the figure in Vol. III., p. 1462), and birds alone; and from this and other features it is pretty certain that the latter are derived from reptiles more or less closely-allied to this or the preceding group of dinosaurs; the resemblance in the one case being closest in the structure of the pelvis, and in the other of the hind-limb. All the bird-like dinosaurs are further

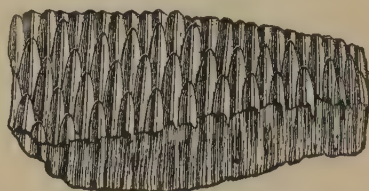
characterized by the presence of a separate chin bone (*pd* in the figure on p. 2359) at the extremity of the lower jaw; by the absence of teeth from the front of both jaws; by the teeth themselves approximating more or less closely to the type of the



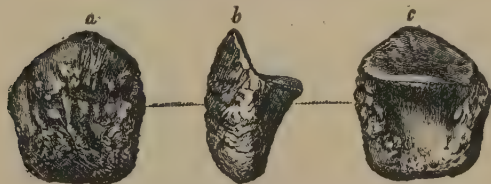
OUTER AND LATERAL VIEWS OF A TOOTH
OF THE IGUANODON.

one here represented, and by being frequently not implanted in distinct sockets; and likewise by the vertebræ being completely solid throughout. The typical representatives of this group are the well-known iguanodons, originally described on the evidence of teeth, from the Wealden rocks of England, but now known by entire skeletons from the corresponding deposits of Belgium, which are exhibited in the museum at Brussels. These reptiles, which were represented by allied forms in the United States, habitually walked on their three-toed hind-limbs, the largest individuals attaining a length of some thirty-three feet. They are characterized by the limb bones being hollow, by the length of the metatarsal bones of the foot, by the first digit of the five-toed fore-limb being converted into a large conical spine, and also by the teeth being of the type of the one shown in the accompanying figure. Needless to say, animals with such teeth must have been purely vegetable feeders, as indeed were all the other members of this group. The hind-feet terminated in rather sharp claws, and there was no bony armor on the body. The iguanodons probably stalked about among the palm forests of the Wealden period, on the leaves and fruit of which they may be presumed to have in great part subsisted. In these reptiles the large, flattened, and serrated teeth were arranged in each jaw in a single row, but in certain smaller forms known as trachodons which occur in the higher Cretaceous rocks of both Europe and North America, there were several rows of teeth in

use at the same time, the edges of these teeth being so flattened and fitted together that a pavement-like structure resulted. These trachodons were all much inferior in size to the gigantic iguanodons. The American clausosaur (*Claosaurus*), of which the skeleton is figured on p. 2393, differs from the iguanodons



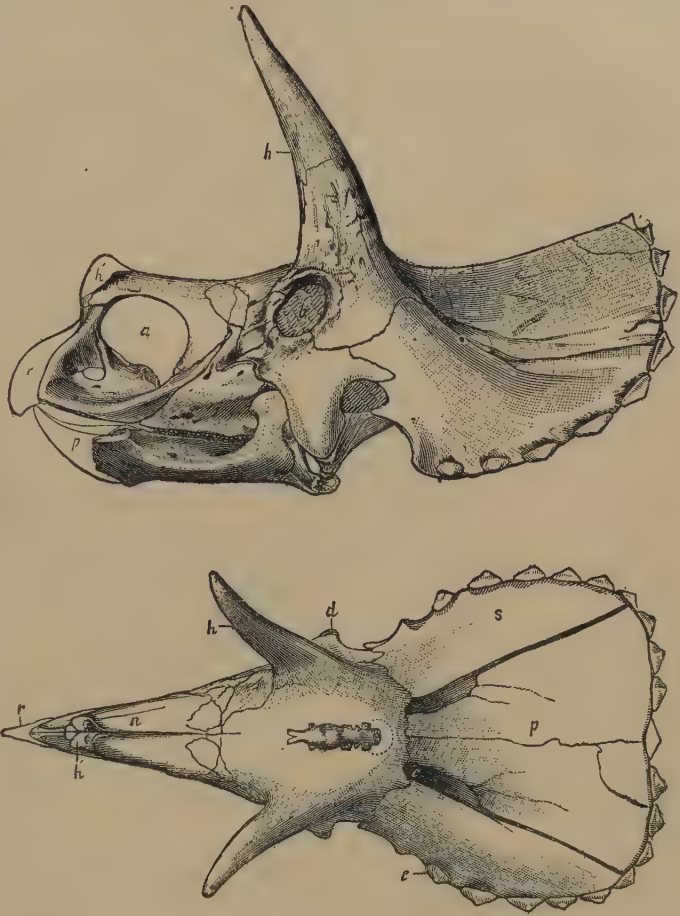
PAVEMENT-LIKE TEETH OF THE
TRACHODON.—After Marsh.



TERMINAL TOE BONE OF AN ARMORED
DINOSAUR.—After Marsh.

in having the fore-paw of normal structure. Nearly-allied to the iguanodons are the remarkable armored and horned dinosaurs, which constitute a subgroup characterized by their solid limb bones, the presence of some kind of bony armor, the

short foot bones, frequently terminating in hoof-like toes, and the habitually quadrupedal gait. Commencing in the British Lias, these extraordinary reptiles continued throughout the Secondary period, and seem to have attained their maximum development at the close of the Cretaceous epoch in the United States. Of the armored forms, the huge stegosaur of the English Oxford, and Kimeridge Clays, and the corresponding rocks of the United States, was characterized by the possession of large quadrangular bones, which are believed to have been arranged in a vertical position down the middle of the back, while the tail was protected by some formidable spines, as shown in the greatly reduced restoration of the skeleton given on p. 2360. Still more strange were the somewhat later horned dinosaurs (*Ceratops*, etc.), of which two views of the skull and a more reduced restoration of the skeleton are here given.

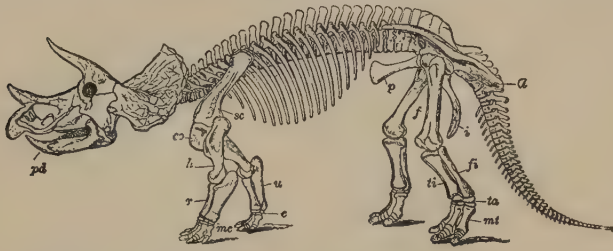


UPPER AND SIDE VIEWS OF THE SKULL OF A HORNED DINOSAUR.

a. nostrils; *f.* brain; *h.* horn; *n.* nasal bones; *p.* chin bone; *r.* extremity of upper jaw.—After Marsh.

In these extraordinary creatures the hinder part of the head was provided with a pair of bony horn-like projections, which were doubtless insheathed during life with hollow horns, like those of oxen; and there was also a single horn of variable size on the nose. The skull was further remarkable for the expansion of its hinder extremity into a fan-like shield overhanging and protecting the vertebræ of the neck. Some idea of the huge dimensions attained by these dinosaurs will be conveyed by the statement that an immature skull of one of the species measures upward of six feet, while fully adult ones must have been considerably larger. The extraordinarily small size of the brain of these creatures is indicated in the lower figure of the skull. Externally the bodies of these dinosaurs were protected by granules and plates of bones, which, like those of crocodiles, were probably overlain with horny

shields. It has yet to be mentioned that in the horned dinosaurs, as shown in the figure of the skeleton, the posterior bar of the pubis has disappeared, and only the



RESTORATION OF THE SKELETON OF A HORNED DINOSAUR. *pd.* chin bone. Other letters as in the figure on p. 2360.—After Marsh.

front branch remains, thus causing the whole pelvis to simulate that of the carnivorous group, to which it has no real resemblance.

We have yet to learn the reason why, at the close of the Secondary period, these mighty dinosaurs, together with the flying dragons which at the same time tenanted the air, and the fish lizards and plesiosaurs which peopled the sea, should, one and all, disappear—and that apparently suddenly—to make way for mammals and birds, which henceforth became the lords of creation.

FLYING DRAGONS, OR PTERODACTYLES

Order *ORNITHOSAURIA*

At the present day bats and birds are the only Vertebrates endued with the power of true flight, but during the Secondary period, when the former were unknown and the latter but poorly represented, the place of both was taken by the flying dragons, or, as they are called, from the structure of their wings, Pterodactyles. While agreeing with crocodiles in the essential structure of their skulls and in their two-headed ribs, these curious reptiles have the other portions of their skeleton more or less specially modified for the purposes of flight. In the relatively-large size of the brain—which is doubtless essential for a flying animal—and general bird-like form of the skull, as well as in the keeled breastbone and general form of the collar bones (although these are not welded together into a furcula), the pterodactyles present a curious similarity to birds. Misled by these resemblances, some anatomists have, indeed, been induced to consider that the two groups are nearly related, although a more mistaken notion never existed. Such resemblances as do exist between the two groups are due, indeed, to that parallelism in development to which we have already had occasion to call attention as existing between totally different groups of animals whose mode of life is similar.

The most distinctive feature of the pterodactyles is to be found in the modifications of the bones of the fore-limbs for the purpose of supporting a wing, which took the form of a membranous expansion of skin analogous to that constituting the wings of bats. This wing was mainly supported by the great elongation of the bones of the fifth digit or finger of the fore-limb, as shown in the figure of the skeleton on the following page, and likewise in the restored representation of one of these reptiles. The membrane thus supported seems to have extended backward along

the sides of the body to include the upper portions of the legs, between which it was extended to embrace the base of the tail in those forms in which the latter appendage was fully developed. Moreover, in the long-tailed species, the extremity of the tail itself was provided with a racket-shaped expansion of membrane, which may have served the purpose of a rudder in flight. If it be asked how the presence of such membranes is known, it may be answered that in many of the specimens of these reptiles entombed in the fine-grained lithographic limestones of Bavaria the actual impressions of these membranes have been preserved. The elongated fifth finger of the wing had no claw at the extremity, although the three middle fingers were thus provided. With regard to the first finger, or the one corresponding to the human thumb, this may have been represented by the small splint-like bone seen depending from the wrist in the figured skeleton. The hind-limbs present no special peculiarities, but, as most of the bones of the skeleton were hollow and permeated by air, like those of birds, we may infer that the lungs were probably also constructed after the avian fashion. The vertebræ of the neck resembled those of living crocodiles in having a ball at the hinder end of the body and a cup in front. In general conformation the skull was remarkably bird-like, the snout being produced into a beak, which in some cases was provided with teeth, while in others, as shown in the figure on p. 2362, it was toothless, and probably insheathed during life with horn. Bird-like features are likewise shown by the large size of the brain case, of which the component bones were fused together, and also by the union of the extremities of the two branches of the lower jaw.



SKELETON OF PTERODACTYLE.

The creature is lying on its back, with the head bent to the left side. *a.* indicates the left pubic bone; the haunch bone or ilium being shown on the opposite side.

Pterodactyles flourished during the greater part of the Secondary period, dating from the epoch of the Lias, and continuing to the close of the one during which the Chalk was deposited. They are represented by several well-marked types, which may be arranged under three family groups. Of these the most specialized forms are the toothless pterodactyles or pteranodonts, from the Cretaceous rocks of North

America; some of these toothless members of the order far exceeded any flying bird in point of size; the estimated span of wing in the largest species being upward of five-and-twenty feet. This group may be distinguished not only by the total absence of teeth, but likewise by the great backward extension of the hinder extremity of the skull.

In the typical pterodactyles (*Pterodactylus*, etc.) the jaws were provided with teeth,—which may, however, have been very small in size and few in number,—while the skull, as shown in the figure of the skeleton on p. 2397, was not produced backwardly, and the tail was reduced to a rudiment. The members of this



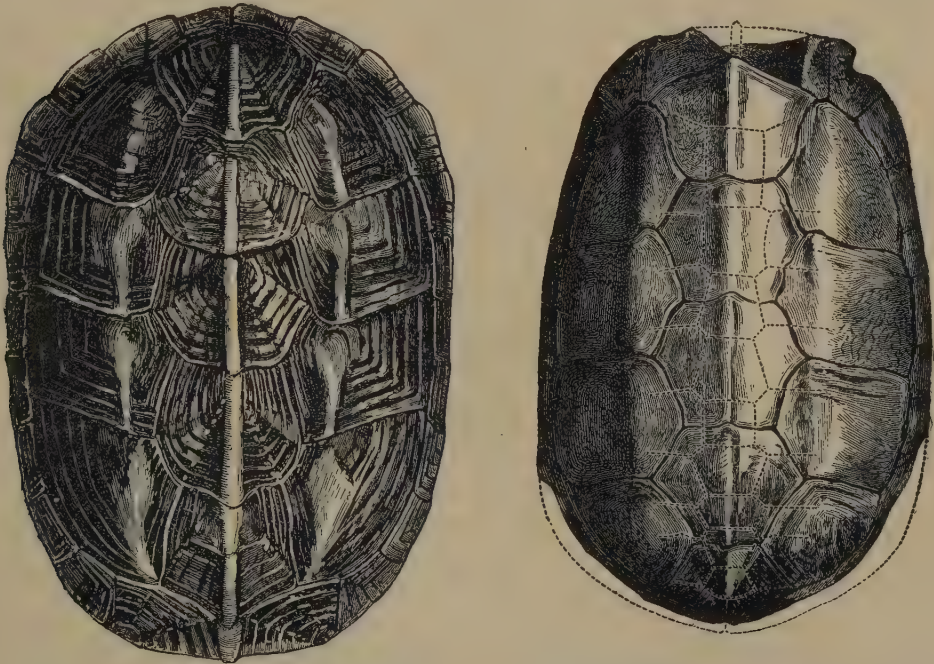
RESTORATION OF A LONG-TAILED PTÉRODACTYLE.
(One-seventh natural size.)
(After Marsh.)

group, which are common in the Oölitic rocks of the Continent, vary in size from the dimensions of a sparrow to those of an eagle. Lastly, we have the long-tailed pterodactyles (*Rhamphorhynchus*, etc.), which are likewise of Oölitic and Liassic age, and are at once distinguished, as shown in the restoration, from the members of the preceding group by the fully-developed tail. These long-tailed species are evidently the most generalized members of the order; and in the retention of the tail in the generalized group, and its loss in the more specialized one, the reader will not fail to notice an exact parallelism between ordinary bats and the more highly-developed fruit bats.

CHAPTER III

TORTOISES, TURTLES, AND PLESIOSAURS — ORDERS CHELONIA AND SAUROPTERYGIA

AMONG all existing reptiles the most easily defined are those commonly known as tortoises and turtles, and technically as Chelonians, since the presence of a more or less fully-developed bony shell investing the body, and containing within it the upper portions of the limbs, at once separates them from all other members of the class. Indeed, so utterly strange is the confirmation of these extraordinary

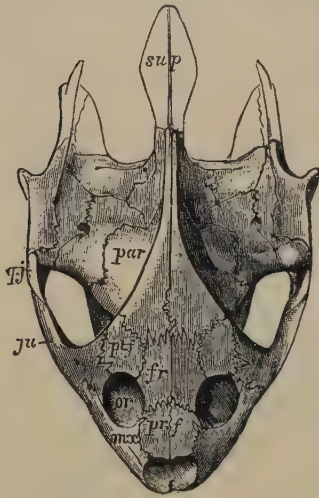


UPPER SHELL OF THE CHAIBASSA TERRAPIN, AND A FOSSIL SPECIMEN OF THE SAME IN WHICH THE HORNY SHIELDS ARE WANTING.

reptiles, that if they were met with only in the fossil state they would inevitably be regarded as among the most marvelous of all creatures. Here however, as elsewhere, the time-honored proverb holds good, and our very familiarity from childhood, with the common European land tortoise undoubtedly tends to render us inappreciative of the marvelous bodily confirmation of this group of reptiles.

Although the presence of a bony shell is of itself sufficient to distinguish the group from other living reptiles, it is necessary to add somewhat to this in order to

give a comprehensive definition. As regards the skull, this resembles that of the crocodiles, in that the quadrate bone, with which the lower jaw articulates, is firmly wedged in among the adjacent bones, to which its relations are, however, somewhat different. Unlike all crocodiles the jaws are, however, entirely devoid of teeth, and are incased with horn, so as to form a cutting beak, which is invariably short. A further peculiarity in the skull of a tortoise is to be found in the presence

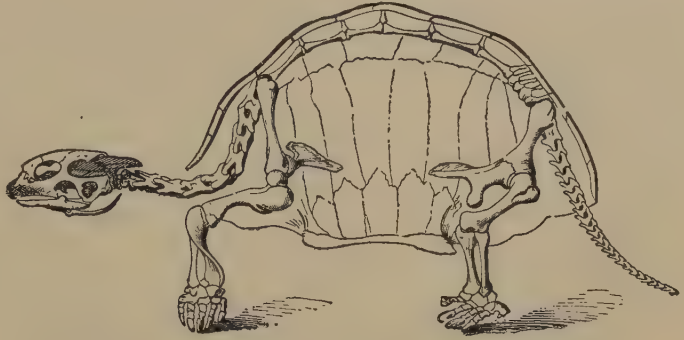


UPPER VIEW OF THE SKULL OF THE
SOFT TORTOISE OF THE GANGES.

of a greatly-developed median spine (*sup*) projecting backward from the hinder region; externally to which are a pair of shorter processes. In other respects, the skull is extremely variable, the sockets of the eyes being sometimes, as in the figure on p. 2404, surrounded by bone, while in other cases they are open behind. Sometimes, moreover, the bony roof behind the eye socket in same the figure may be prolonged backward so as to cover the whole of the region marked *par* in the annexed figure. There is an equal amount of variation in regard to the position of the nostrils, which sometimes open on the palate close behind the beak, while they may be situated, as in living crocodiles, close to the hinder extremity of the skull. A most important feature in the structure of these animals is to be found in the circumstance that the ribs have but a single head apiece, and that the more anterior ones articulate at the junction be-

tween two of the vertebræ, so that one portion of the head is applied to one vertebra and the other portion to the adjacent vertebra. This forms an important distinction from the whole of the orders treated in the preceding chapter, in all of which the anterior ribs are provided with two heads, both of which articulate to the sides of one and the same vertebra. Passing on to the consideration of the bony shell, we find this to consist of an upper portion or carapace, shown in the figure at the commencement of the chapter, and of an inferior portion, covering the lower aspect of the body, which is termed the plastron. When this shell attains its fullest development, the upper and lower moieties are completely connected, as shown in the following figure of the skeleton of a land tortoise; but in certain groups the two remain more or less separate, and in some cases the lower shell is but very slightly developed. Moreover, while the carapace is generally immovably welded to the vertebræ of the back and the ribs, in the so-called leathery turtle it is separate from both. In its fullest developed form, the shell consists of a series of bones articulating with one another at their edges by finely denticulated sutures, and thus forming a continuous whole capable of increasing in size by growth at the edges of its component elements. In the carapace, the bones forming the middle of the back are formed by expansions growing from the spines of the vertebræ, while the large lateral plates grow upon the ribs, from which they are inseparable. Within the cavity thus formed are placed the bones of the shoulder and pelvis, to which are respectively articulated the arm bone and thigh bone, so that, as shown in the figure

of the skeleton, these bones actually come within the ribs, instead of being external to them, as in all other living animals. At the fore and hinder extremities of the shell are left large apertures, through which are protruded the head and neck, the fore- and hind-limbs, and the tail. A large number of tortoises are able to retract both the head, limbs, and tail within the margins of the shell, the apertures of which are then filled up; such portions of the head and limbs as are exposed being protected by horny shields.



SKELETON OF TORTOISE IN LONGITUDINAL SECTION.

With the exception of the marine leathery turtles and the fresh-water soft tortoises, in which it is invested merely with a continuous leathery skin, the shell of Chelonians is covered with a number of horny plates, which, in the adult state at least, are in contact with one another by their edges. As these horny shields are very important in determining the different species of tortoises, it is essential to enter in some detail into their mode of arrangement, and the names by which they are known. In the carapace of any ordinary tortoise, such as the one represented in the left-hand figure at the head of the chapter, we shall find that the middle line of the back, exclusive of the margins, is occupied by a single row of large polygonal shields, symmetrical in themselves; these shields, which are marked *v* in the following diagram, being known as the *vertebrals*. On either side of this median series is another row of shields *c*, which are not symmetrical in themselves, and are termed *costals*. The extreme margins of the carapace are formed by a large series of much smaller shields, of which the anterior, unpaired one (*nu*) is termed the *nuchal*, and the posterior (*ca*), which may be either single or double, the *caudal*. Between the nuchal and the caudal are a series, generally eleven in number on each side, designated *marginals* (*m*). These same marginal shields, being angulated, pass over the edges of the middle portion of the shell, and thus cover the sides of the middle of the plastron, or lower shell, as shown in the right-hand figure of the following diagram. The shields of the plastron proper are generally arranged in pairs, which may be termed, commencing anteriorly, *gulars* (*gu*), *humeral*s (*hu*), *pectorals* (*pc*), *abdominals* (*ab*), *femorals* (*fe*), and *anals* (*an*). In some cases, as will be illustrated in the sequel, the two gulars, may, however, be separated by a single *intergular*; while, as is shown in the diagram, there is frequently an *inguinal* shield immediately in advance of each notch for the hind-limbs.

This disposes of the external horny shields; but a few words are necessary with regard to the bony elements constituting the shell of a tortoise. On stripping off these horny shields from the carapace of a tortoise, the underlying solid shell, as shown in the right-hand figure at the head of the chapter, will be seen to be

marked by a series of channels corresponding to the borders of these same shields. If the shell be not that of a very aged animal, there will be seen in addition a number of finely jagged sutures, marking the divisions between the component bones; and it will be noticed that in their plan of arrangement, although not in number, size, or shape, these underlying bones correspond very closely with the overlying horny shields. Thus, in the middle line of the carapace we have a series of polygonal plates, symmetrical in themselves, and attached to the summits of the vertebræ, which are known as *neurals*; these being clearly indicated in the figure referred to. In front, the series is completed by a large *nuchal* plate, having no connection with the backbone, while behind it terminates in one or two *pygals*, which are like-

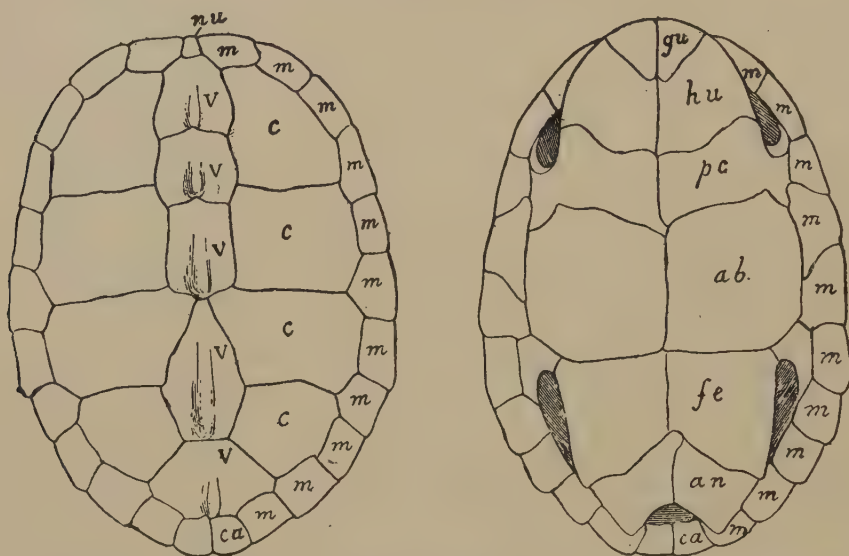


DIAGRAM OF THE HORNY PLATES ON A SHELL OF A FRESH-WATER TORTOISE.

(After Günther.)

wise perfectly distinct from the vertebræ. Externally to the neurals are placed on either side the eight *costal* plates, so named from being attached to the ribs; the inner halves of these plates being alone visible in the shell figured at the head of the chapter, which belonged to a rather aged animal. Finally, the edges of the carapace are formed by the *marginal* plates, which, like the horny shields similarly named, are angulated, and form the lateral borders of the middle portion of the plastron. In the plastron itself, we find its anterior portion formed by a pair of plates, known as the *epiplastrals*, corresponding to the collar bones, or clavicles, of other Vertebrates; while between or behind these is a single unpaired *entoplastral* element, which may be either dagger shaped or rhomboidal, and which represents the interclavicle of less specially modified reptiles. The remainder of the plastron is formed by three pairs of plates, respectively known as the *hyo*, *hypo*, and *xiphiplastrals*, of which the latter or hindmost are generally more or less deeply notched or forked. These three elements appear to correspond to the so-called abdominal

ribs of crocodiles; and it will thus be evident that Chelonians have no representative of the breastbone, or sternum, which is so commonly present in other groups of Vertebrates.

As regards their limbs, the members of this order present a great amount of variation, some of them, like the land tortoises, having the feet adapted for walking, while in the turtles the entire limbs are modified into paddles for swimming. In some cases, each of the five toes may be furnished with strong, curved claws, but in others, like the soft tortoises, only three are thus armed. As a general rule, the number of joints in the toes of the fore-limb, counting from within outward, is 2, 3, 3, 3, 3, while in the hind-limb they are more generally 2, 3, 3, 3, 2, although in a few species the number is the same as in the fore-limb. In both limbs the number of these joints may, however, be reduced, but, except among the soft tortoises, they are never augmented. Very generally, the surfaces of the limbs, especially the anterior ones of the front pair, are protected by horny plates of variable size, which, among the land tortoises, may be underlaid by nodules of bone.

In habits the members of the order display as much diversity as in structure; some being carnivorous and others herbivorous, while some are marine, others fresh water, and others, again, more or less exclusively inhabitants of dry land. All, however, are fond of water, and even the most strictly terrestrial species can, we believe, swim. With the exception of the turtles, the eggs are hard shelled, and these are in all cases deposited on land, the turtles resorting to the shore at certain seasons for this purpose. As regards distribution, tortoises are especially characteristic of the warmer parts of the globe, only two species inhabiting Europe and these confined to the more southern parts of the Continent. The various groups and families are, however, by no means equally distributed over the different regions of the globe. The side-necked tortoises, for instance, are now exclusively confined to the Southern Hemisphere, and in Australia are the only representatives of the order; whereas the S-necked group attains its greatest development in the opposite half of the world, although represented in many countries lying to the south of the Equator. The soft river tortoises, again, are confined to the waters of Asia, Africa, and North America, being totally unknown both in South America and in Australasia. Giant land tortoises within comparatively recent times have been confined to what are known as oceanic islands, although they formerly occurred on most of the large continents; while the smaller members of the same genus are far more numerous in South Africa than they are in Asia. Geologically, the order is a very ancient one, being represented throughout the whole of the Secondary period, and thus commencing at a date when true crocodiles are not known to have come into existence.

According to our own views of their mutual relationships, the Chelonians may be divided into three main groups, or suborders, which may be severally designated S-necked tortoises (including the turtles), side-necked tortoises, and soft tortoises. Some writers would, however, remove from the first group the so-called leathery turtle, to make it the type of a group equal in value to the whole of the other three, which are thus collectively brigaded under a common title. Adopting the former arrangement, we commence our survey of the various members of the order with

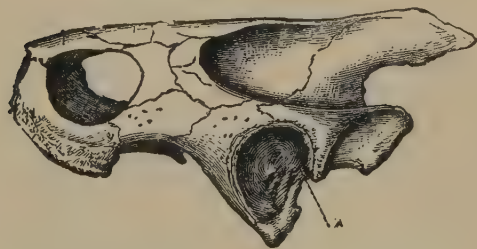
THE LAND TORTOISES AND TERRAPINS

Family *TESTUDINIDÆ*

The land tortoises, together with the greater number of the fresh-water tortoises, or terrapins, of the Northern Hemisphere, as well as their southern allies, collectively constitute one of several families belonging to the first great group of the order. From the circumstance that all its members are so constructed as to be able to withdraw their heads within the margins of the shell by a bending of the neck in an S-like manner in a vertical plane, the group may be conveniently designated S-necked tortoises, their scientific designation being *Cryptodira*. Since, however, the soft tortoises likewise retract their heads in a similar manner, it is obvious that this characteristic alone will not suffice to define the group, and it must accordingly be supplemented by others. Although the degree of ossification of the shell is very variable in the group, the carapace and plastron being in some cases welded into a complete box, and in other instances separate, yet, except in the leathery turtle, there is invariably a complete series of marginal bones, connected with the ribs; the presence of the full series of marginals, together with the S-like retraction of the neck, being sufficient to distinguish the group. A peculiarity in which the members of the group differ from those of the next one, is to be found in the circumstance that the bones of the pelvis remain throughout life unconnected with the plastron; while in the greater number of cases the latter, as shown in the accompanying figure, comprises only six pairs of horny shields, there being no intergular shield between the first pair, or gulars. The skull is characterized by the tympanic ring (*t* in the accompanying figure) having a notch in its hinder border, and also by the con-



THE LEFT HALF OF THE
PLASTRON OF THE CHAI-
BASSA TERRAPIN.



SIDE VIEW OF THE SKULL OF A LAND TORTOISE
WITH THE LOWER JAW REMOVED.

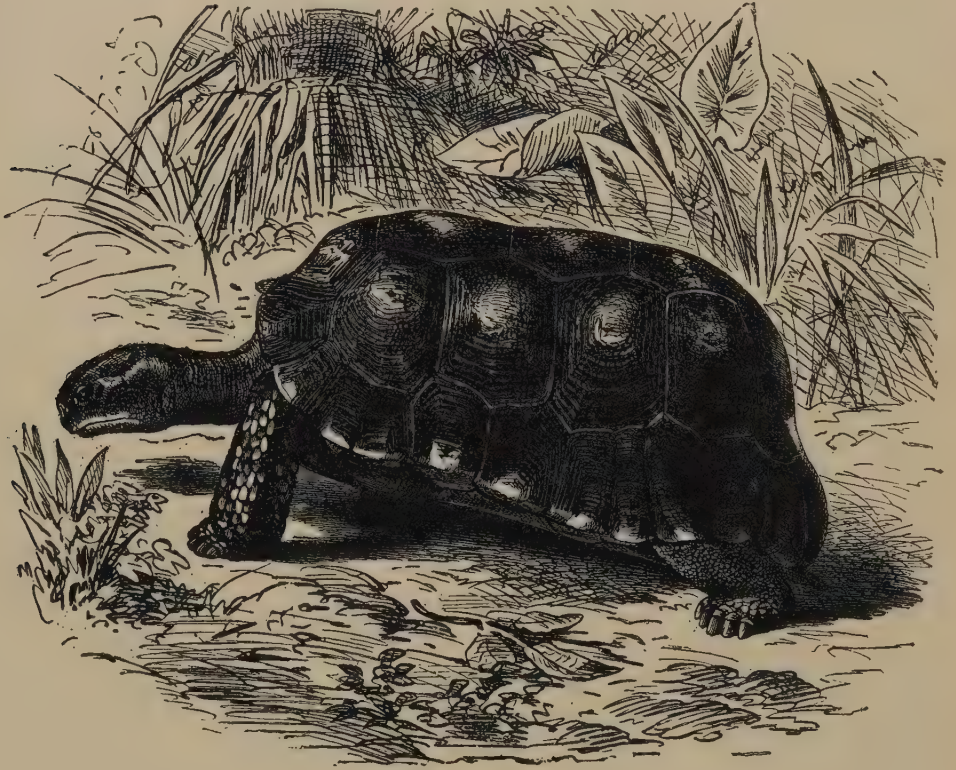
dyle on its quadrate bone fitting into a hollow at the hinder end of the lower jaw. This S-necked group includes the marine turtles, and all the tortoises of the Northern Hemisphere, with the exception of the soft river tortoises, and thus comprises by far the greater number of the living representatives of the entire order. Although well represented in Africa and South America, the group is quite unknown in Australia.

The land tortoises and terrapins of the family *Testudinidae* have the shell well developed and of a more or less ovoid shape; the plastron being connected with the carapace either by a straight articulation or by means of sutures, while it never has an intergular shield in front. The limbs are adapted more or less completely for walking, and are never modified into paddles, while the head is capable of complete retraction within the margins of the shell. A very important structural feature in the shell is that the nuchal, or unpaired median bone in the front of the carapace, does not send back processes underlying the marginal bones of the same; while in the tail each vertebra has a cup in front of its body or lower portion, and a ball behind. None of the members of the family are marine, but while some are inhabitants of the land, others are more or less exclusively dwellers in fresh water. There are, moreover, equally important differences in regard to their food, all the land forms being herbivorous, while of those frequenting the water some subsist on vegetable, and others on animal substances.

By far the most numerously represented genus of the whole family
Land Tortoises is the one including the true or land tortoises, of which there are rather more than forty existing species (counting a few that have been exterminated within the historic period). These tortoises, of which a few are more or less aquatic in their habits, have the upper and lower portions of the shell completely welded together, the former being frequently very convex and much vaulted, while the top of the head is covered with large horny shields. The limbs, which are entirely adapted for walking, are of a club-like form, and are covered with large horny scales or tubercles; their toes being unwebbed and furnished with strong, claw-like nails. The tail is always short, its proportionate length not being greater in the young than in the adult. More important characteristics are, however, furnished by the bony shell and skull, to observe the former of which it is of course necessary that the horny shields should be stripped off. In a shell thus treated it will be seen that the unpaired median neural bones of the carapace are relatively-short and wide, and so arranged that a four-sided one is interposed between two that are octagonal, although in some cases they are mostly hexagonal; while the costal or lateral plates are alternately narrow above and broad below. Moreover, the line dividing the costal horny shields from the marginals usually corresponds with the suture between the corresponding bones of the carapace, whereas in the other members of the family one is above the other; while a further peculiarity of most species of the genus is that there is but a single caudal horny plate at the hinder end of the carapace. In the skull the palate is provided with one or two ridges on each side, while the hinder aperture of the nostrils is situated on the line of the eyes. It may be mentioned here that, as in the majority of the representatives of the order, the form of the shell differs considerably in the two sexes, the male having the central region of the plastron deeply concave, while in the females it is flat or slightly convex.

True tortoises are distributed over Southern Europe and Asia, the whole of Africa, the southern portions of North America, and South America (inclusive of the Galapagos islands). They are strictly herbivorous in their diet; and certain species now confined to oceanic islands, attain gigantic dimensions, and are by far

the largest representatives of the family. The species inhabiting colder regions hibernate during the inclement season by burrowing in the ground, whereas those found in more genial climates are active throughout the year. All the species appear to be diurnal in their habits, and although they are all fond of water, the common European species always withdraws into its shell at the slightest shower. These reptiles will live to an enormous age, which, in some instances at least, may be reckoned by centuries. According to the classification adopted by Mr. Boulenger, the species of this extensive genus may be arranged under seven groups, of which we proceed to notice representative species.



BRAZILIAN TORTOISE.
(One-fourth natural size.)

**Florida
Tortoise**

The land tortoises of North America include three species, of which one of the best known is the Florida tortoise (*Testudo polyphemus*), inhabiting the Southeastern United States. All these species may be easily recognized by the anterior extremity of the palate of the skull having a median longitudinal ridge, instead of the deep pit characterizing all other members of the genus. In the Florida tortoise, as well as in the allied Agassiz's tortoise (*T. agassizi*), the length of the shell is more than twice its height, while the beak is not hooked, and the fore-limb is broadest at its extremity. On the other hand,

in Berlandier's tortoise (*T. berlandieri*), from Mexico and Texas, the shell is proportionately shorter, the beak is hooked, and the fore-limb widest at the elbow. These species are all of small size, not exceeding ten inches in length.

Brazilian

Tortoise

The Brazilian species (*T. tabulata*), figured above, represents a group by itself, of which the distinctive characteristics are as follows:

The carapace is much elongated and somewhat depressed, with its margins not everted, its general color being dark brown or black, with a yellowish centre to each of the shields on the back. The nuchal shield of the carapace is wanting; while in the plastron the gular shields, although well developed, are prolonged anteriorly into hem-like processes. The head and limbs are marked with orange or red spots, on a dark ground. This handsome tortoise, which attains a length of nearly twenty-two inches, is an inhabitant of tropical South America, to the east of the Andes, and also of the Windward islands, ascending to an elevation of about two thousand feet. In many wooded districts it appears to be very abundant, feeding not only on leaves and grasses, but likewise on the fallen fruit which is to be met with in great quantities. In the hot season it constructs a nest of dry leaves, wherein are deposited its eggs, which may be a dozen or two in number. When first hatched, the young are of a uniform yellowish-brown color, with their shells still soft. The young, and to a less degree the adults, have, according to the Prince of Wied, numerous enemies. Against the puma and jaguar the stout shell of even the adult seems to be no defense, since, according to native reports, those animals, on finding one of these tortoises, will set it up on end and scoop out the flesh with their paws; while from the occurrence of broken shells in the forest it would seem that in some cases they are actually able to tear the plastron away from the carapace. As the flesh is devoid of smell, it is likewise eagerly sought after by both Indians and Portuguese, who are in the habit of keeping these tortoises—known in Brazil by the name of schabuti—in stews, where they are fattened for the table. They are also allowed to run about the houses, where they are fed chiefly on plantains.

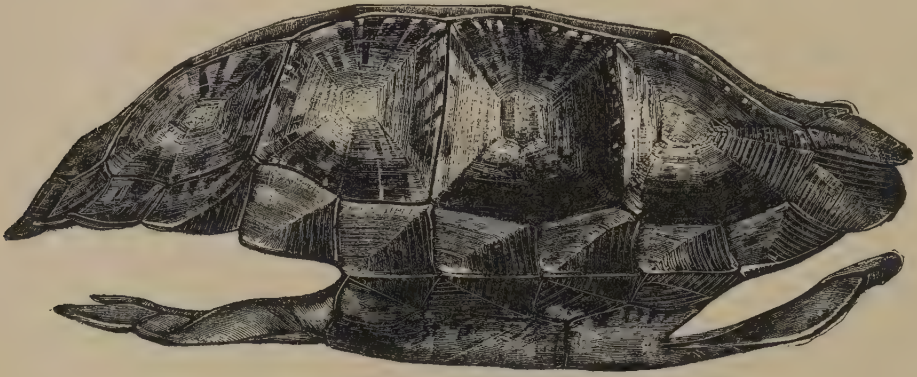
Burmese

Brown

Tortoise

The four species belonging to the third group, of which the Burmese brown tortoise (*T. emys*) is an example, are characterized by the presence of some very large conical, bony, spur-like tubercles on the lower portion of the hind-leg, and the circumstance that the length of the union in the middle line of the anal shields of the plastron is considerably less than that of the abdominal shields; the color of the carapace in the adult being either uniform brownish, or yellowish brown closely spotted with black. The Burmese brown tortoise, which attains a length of eighteen inches, while agreeing with the species above noticed in the possession of a nuchal shield on the front of the carapace, differs in that the caudal shield at the hinder extremity of the same is divided, as in the terrapins. The shell of this species is much depressed, with the anterior and posterior borders of the carapace serrated; the adult being dark brown, or blackish in color, while in the young the carapace is yellowish brown, with dark brown markings. In addition to the spur-like tubercles on the back of the heel, the whole of the front of the fore-limb is overlain with imbricating bony tubercles, arranged in four or five longitudinal rows, and there are some conical ones on the

back of the thigh, as well as others on the lower surface of the hind-foot. This species is an inhabitant of Assam, Burma, Siam, the Malay Peninsula, and Sumatra, where it frequents moist wooded districts, and is believed to be largely aquatic in its habits. The association of a divided caudal shield, with habits reputed to resemble those of the terrapins, is somewhat noteworthy.



SIDE VIEW OF SHELL OF BURMESE BROWN TORTOISE.

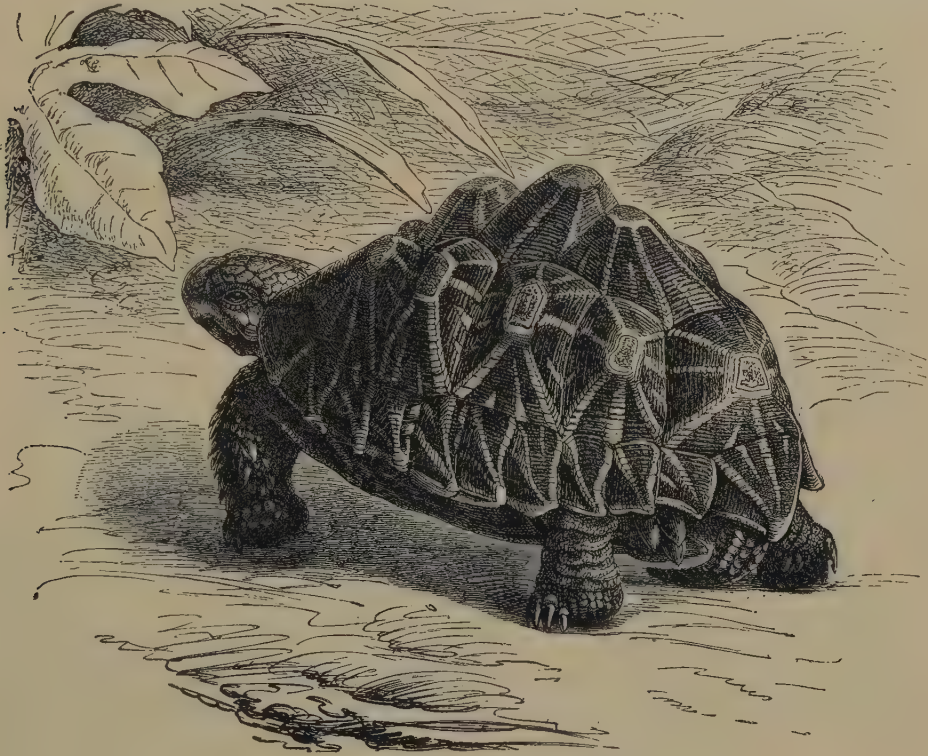
(From Günther, *Proc. Zool. Soc.*, 1882.)

In the other three members of this group the nuchal shield is wanting, and the caudal single. Of these, the Argentine tortoise (*T. argentina*) of South America, and the spurred tortoise (*T. calcarata*) of Africa, are characterized by their flattened and uniformly brownish-colored carapaces. On the other hand, the handsome leopard tortoise (*T. pardalis*) of Southern Africa, has the carapace highly vaulted, and closely spotted with black upon a yellowish-brown ground, its anterior margin being very deeply notched.

The fourth group comprises about ten very beautifully-colored small, or medium-sized, tortoises, the great majority of which are confined to South Africa, although the species here figured (*T. elegans*) is an inhabitant of India and Ceylon. All these species are easily recognized by the carapace being extremely convex, and either black in color, with yellow lines radiating from the centre of each of the shields of the back, or yellow, or brownish, marked with radiating black lines. Frequently, moreover, the shields of the back are swollen, so as to form more or less prominent bosses. The Indian species, together with an allied one (*T. platynota*), from Burma, is distinguished from all the other members of the group by the absence of the nuchal shield at the front of the carapace. Of the other eight species no less than seven are South African, while the radiated tortoise (*T. radiata*) is from Madagascar; one of the best-known members of the group being the common geometric tortoise (*T. geometrica*) of the Cape, which attains a length of some five and one-half inches. In the eyed tortoise (*T. oculifera*) the pectoral shields of the plastron may not meet in the middle line, as is the case in some individuals of the Burmese brown tortoise. While the elegant and geometric tortoise have the carapace black, with narrow yellow rays, in the

eyed tortoise the markings take the form of brownish yellow and dark brown rays of nearly equal width.

An admirable account of the habits of the elegant tortoise is given by Captain T. Hutton, from which the following extracts are made. These tortoises are fairly common in dry, hilly districts, where they inhabit the high grass jungles at the foot of the hills. Nevertheless, they are by no means easy to find, owing to their color and appearance harmonizing so closely with the rocky ground, and from their habit of remaining in concealment beneath shrubs or tufts of grass during the heat of the day. They are tracked by the Bhils of Meywar to their hiding places by fol-



ELEGANT TORTOISE.
(One-third natural size.)

lowing the trail of their footsteps in the dry sand, the same method being employed by some of the wild tribes of South Africa in the case of the allied species inhabiting that continent. In the rainy season the elegant tortoise is, however, extremely active, and wanders about in search of food at all hours of the day. At the approach of the cold weather these reptiles select a sheltered spot, where they conceal themselves by thrusting their shells into thick tufts of bushes or shrubs, in order to be better protected from the cold. There they remain in a kind of lethargic, although not truly torpid, state, till the hot season, when they issue out to feed only after sunset and in the early morning. Specimens kept in captivity were observed



(2410)

GIANT TORTOISES OF THE GALAPAGOS ISLANDS.

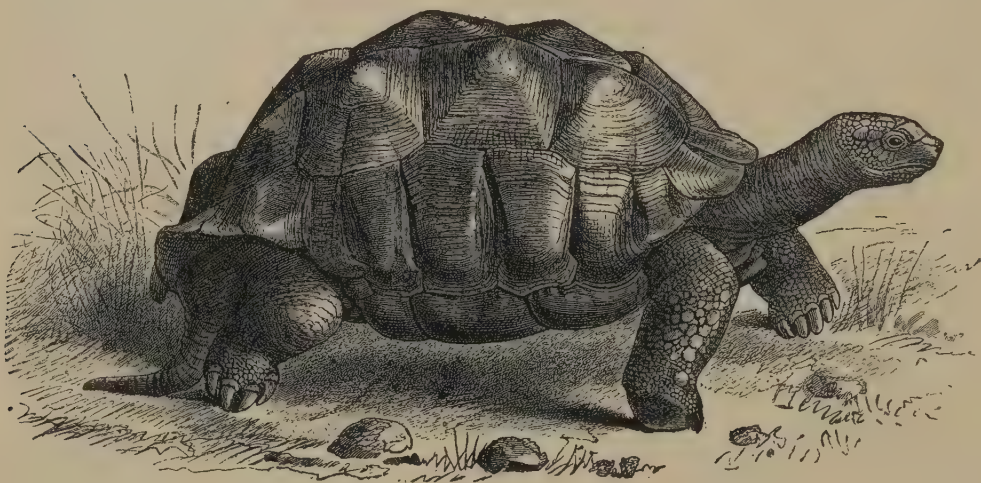
to be very fond of plunging into water during the hot season, where they would remain for half an hour at a time. They also drank large quantities of water at this period of the year, which they took by thrusting in their heads and swallowing in a series of gulps. About November the female lays her eggs in a shallow pit excavated by herself. One of the aforesaid captive specimens in the course of about two hours "succeeded in making a hole six inches in depth and four inches in diameter; in this she immediately deposited her eggs, four in number, filling up the hole again with the mud she had previously scraped out, and then treading it well in, and stamping upon it with her hind-feet alternately until it was filled to the surface, when she bent it down with the whole weight of her body, raising herself behind as high as she could stretch her legs, and suddenly withdrawing them, allowing herself to drop heavily on the earth, by which means it was speedily beaten flat; and so smooth and natural did it appear that, had I not detected her in the performance of her task, I should certainly never have noticed the spot where she had deposited her eggs. She did not immediately leave the place after finishing her work, but remained inactive, as if recovering from her fatigue." In disposition these tortoises are decidedly pugnacious, this being especially the case with the males. These combats seemed to be chiefly trials of strength, "one male confronting the other, with the hind- and fore-legs drawn into the shell, and the hind-feet planted firmly on the ground, and in this manner striving against each other until one or both became fatigued. This was done chiefly when they wanted to pass each other in any narrow space, and sometimes if the one could succeed in placing his shell a little beneath the other, he tilted him over on his back, from which he had great difficulty in recovering himself; and I have frequently found them sprawling thus, making desperate efforts with head and feet to throw themselves back to their natural position, which they were unable to effect unless the ground chanced to be very uneven, so as to assist them."

Giant

Tortoises

During the Pliocene, or later division of the Tertiary period, gigantic land tortoises were, as attested by their petrified remains, widely distributed over the continents of the world, species having been obtained from India, France, and North and South America. The largest of these was the well-known atlas tortoise (*T. atlas*) from the Siwalik hills of Northern India, in which the length of the shell was about six feet, the species itself being apparently allied to the existing Burmese brown tortoise already referred to. Probably more or less abundant during the epoch in question, with the advent of the ensuing Pleistocene epoch giant tortoises seem to have disappeared entirely from the continental areas, to survive on certain oceanic islands where they were free from the competition of large animals of higher organization. Some of these insular species, like those of Madagascar and Malta, did not apparently survive the Pleistocene epoch; while in other regions they flourished and multiplied till the fell presence of man led to their partial or total extermination. At the present day the few survivors of these monstrous reptiles are being rapidly reduced in numbers, and unless special means be speedily taken for their preservation, they will ere long entirely cease to exist. During the historic period the islands where giant tortoises are known to have existed constitute three distinct groups. Two of these are situ-

ated in the Indian Ocean, and comprise Aldabra, to the northwest of Madagascar, and the Mascarene group—including Réunion, Mauritius, and Rodrigues—lying to the east of the same; while the third or Galapagos group, taking its name from the Spanish word for tortoise, is situated in the far distant South Pacific, off the western coast of South America. During the sixteenth and seventeenth centuries, the tortoises are stated to have existed in enormous numbers in all the above-named islands; but as they afforded a most valuable supply of food, and could be kept alive on board ship, their numbers were rapidly reduced in those of the Indian Ocean, and Aldabra is now the only island in that area where they still exist in a wild state. Many of these tortoises were, however, exported to the Seychelles, and it is believed, as we shall notice below, that one carried thence to the Mauritius is the only living example of the species that formerly inhabited Rodrigues. Regarding the abundance of these tortoises in the latter island, François Leguat, writing



ELEPHANT TORTOISE.

in 1691, observes that "there are such plenty of land turtles in this isle, that sometimes you see three thousand of them in a flock, so that you may go above a hundred paces on their backs." In Mauritius they were still abundant in 1740; but about 1761 they were probably scarcer, as thousands were then imported from Rodrigues as food for the patients in the hospitals of the Mauritius. The continued exportation,—some ships taking as many as four hundred at a time,—coupled with the destruction of their eggs and young, finally led to their extermination in both Mauritius and Rodrigues; this extirpation having probably taken place early in the present century. The Réunion tortoise, of which very little is known, seems to have disappeared at a still earlier date, while of the Galapagos species, we shall speak later.

The total number of species of giant tortoises known to have existed within the historic period is about fourteen, the whole of which are characterized by their large size, their long necks, and the uniform dark brown or black color of their shells.

They may be divided into four groups, according to their geographical distribution, each characterized by certain structural peculiarities. The first group comprises the four Aldabra tortoises, characterized by the presence of a nuchal shield on the front of the carapace, and the distinctness of the gulars on the front of the plastron. On the other hand, in the four best-known Mascarene species, constituting the second group, the nuchal shield is wanting, while the two gulars have coalesced into one, the plastron being characterized by its extreme shortness. Lastly, the third, or Galapagos group, with six species, presents a condition intermediate between that existing in the two others, the nuchal shield of the carapace being absent, while the gulars of the plastron remain double. We proceed to notice some of the species of each group.

Aldabra Tortoise The best known of the four species from Aldabra is the elephant tortoise (*T. elephantina*), which differs from the other three in having the horny shields of the carapace concentrically striated, and the plastron of the adult notched behind. One of the species (*T. gigantea*) with smooth shields on a truncated plastron is peculiar in having the caudal shield divided, as in the Burmese brown tortoise. The elephant tortoise appears to be one of the largest of all the species, attaining a length of about four feet. At the present day it is very scarce in its native island, where the few survivors receive a certain amount of protection from the Government of Mauritius, to which Aldabra belongs. There are, however, a few individuals living in Mauritius and the Seychelles.

Mascarene Tortoises Of the Mascarene species the three species from Mauritius (*T. indica*, *trisserrata*, and *inepta*), all of which are extinct, are characterized by the thinness of their carapace, of which the margins are thickened. The Rodrigues tortoise (*T. vosmaeri*) has a still thinner carapace, which in the male does not shelve down in front in the usual manner. Allusion has already been made to the numbers in which these tortoises existed in Leguat's time, but till quite recently it was thought that the species was totally extinct. It appears, however, that in the artillery barracks of Port Louis in the Mauritius, there lives a very ancient tortoise which, in the opinion of Dr. Günther, is probably of this species. This tortoise is one of two which were imported into the Mauritius by the navigator, Captain Marion du Fresne from the Seychelles in 1766, one of these having been subsequently presented to the London Zoological Gardens in 1832 by Sir C. Colville. The latter weighed two hundred and eighty-nine pounds, and its shell measured four feet four and one-half inches in length along the curve, and four feet nine inches in width; while in the Port Louis specimen the circumference of the shell is nine feet three inches, and its height two and one-half feet. Marion's tortoise, as the Port Louis example is called, is thus definitely known to have lived for a hundred and twenty-seven years, and as it was doubtless of large size when brought from the Seychelles, and since all these tortoises take an immense time to reach large dimensions, it is highly probable that it is an actual survivor from the enormous herds that existed in Rodrigues in Leguat's time. From a peculiarity in the structure of the hinder vertebræ of the neck, it appears that the tortoises of this species have the power of raising their necks to a nearly vertical position, which would give them a wide range of vision. This elevated range of vision

would accord well with the account given by Leguat, who writes concerning these tortoises as follows: "There's one thing very odd among them; they always place sentinels at some distance from their troop, at the four corners of the camp, to which the sentinels turn their backs, and look with the eyes, as if they were on the watch."

The various islands of the Galapagos group, such as Abingdon, Galapagos Albemarle, Chatham, Hood, and Charles, are the respective homes of Tortoises one or more species of giant tortoise. Of the various species inhabiting these islands, the blackish tortoise (*T. nigrita*), which is the one given in the illustration on p. 2410, agrees with two others (*T. nigra* and *T. vicina*) in having the horny shields of the carapace concentrically striated in the adult, the figured species differing from *T. nigra* in having the plastron notched, instead of truncate behind. In the other three species the shields on the back are smooth, while the plastron always has its hinder end truncated. In the North Albemarle tortoise (*T. microphyes*), the width of the bridge connecting the upper and lower shells is of considerable length, and the shell itself stout. On the other hand, in the saddled tortoise (*T. ephippium*) and the Abingdon tortoise (*T. abingdoni*) the same bridge is relatively short, and the shell is remarkable for its thinness; the carapace being much narrowed anteriorly, where it is so pinched in at the sides as to have a sharp ridge on the back. In the former of these two species the shell still retains the usual bony framework, but in the second it is soft and leathery. Both have very long necks, which are carried nearly vertically; and in the Abingdon species the notches in the front end of the shell are so large that in a front view the animal appears merely to have a kind of mantle thrown over the body. It is hard to see what can be the object of this softening and atrophy of the shell, but it is quite clear that it renders the animals very liable to injury, and thus probably accounts for the fact that none of them have been brought alive to Europe. The carapace of this species attains a length of thirty-eight and one-half inches, and the weight of one individual was just over two hundred pounds.

The best account of the habits of the Galapagos tortoises is one given by Darwin, regarding the species figured in our engraving, which inhabits, apparently, most of the islands of the group. These tortoises frequent in preference the high damp parts, although they likewise live in the lower and arid districts. They are very numerous, and some grow to such a size that it requires six or eight men to lift them, while they will yield as much as two hundred pounds of meat. "The old males are the largest, the females rarely growing to so large a size; the male can be readily distinguished from the female by the greater length of the tail. The tortoises which live on those islands where there is no water, or in the lower and arid parts of the others, feed chiefly on the succulent cactus. Those which frequent the higher and damp regions eat the leaves of various trees, a kind of berry, which is acid and austere, and likewise a pale green filamentous lichen, that hangs in tresses from the boughs of the trees. The tortoise is very fond of water, drinking large quantities, and wallowing in the mud. The larger islands alone possess springs, and these are always situated towards the central parts, and at a considerable height. The tortoises, therefore, which frequent the lower districts, when thirsty,

are obliged to travel from a long distance. Hence, broad and well-beaten paths branch off in every direction from the wells down to the seacoast, and the Spaniards by following them up, first discovered the watering places. When I landed at Chatham island, I could not imagine what animal traveled so methodically along well-chosen tracks. Near the springs it was a curious spectacle to behold many of these huge creatures, one set eagerly traveling onward with outstretched necks, and another set returning after having drunk their fill. When the tortoise arrives at the spring, quite regardless of any spectator, he buries his head in the water above his eyes, and greedily swallows great mouthfuls, at the rate of about ten in a minute. The inhabitants say that each animal stays three or four days in the neighborhood of the water, and then returns to the lower country, but they differ respecting the frequency of these visits." After mentioning that some tortoises live on islands where the only water they obtain is that which falls as rain, and also that the inhabitants of the Galapagos islands, when overcome with thirst, are in the habit of killing a tortoise and drinking the water contained in its interior, the writer proceeds as follows: "The tortoises, when purposely moving towards any point, travel by night and day, and arrive at their journey's end much sooner than would be expected. The inhabitants, from observing marked individuals, consider that they travel a distance of about eight miles in two or three days. One large tortoise, which I watched, walked at the rate of sixty yards in ten minutes, that is three hundred and sixty yards in the hour, or four miles a day,—allowing a little time for it to eat on the road. During the breeding season, when the male and female are together, the male utters a hoarse roar or bellowing, which, it is said, can be heard at a distance of more than a hundred yards. The female never uses her voice, and the male only at these times; so that when the people hear this noise, they know that the two are together. They were at this time (October) laying their eggs. The female, where the soil is sandy, deposits them together, and covers them up with sand; but where the ground is rocky, she drops them indiscriminately in any hole; Mr. Bynoe found seven placed in a fissure. The egg is white and spherical; one which I measured was seven and three-eighths inches in circumference, and therefore larger than a hen's egg. The young tortoises, as soon as they are hatched, fall a prey in great numbers to the carrion-feeding buzzard (*Polyborus*). The old ones seem generally to die from accidents, as from falling down precipices; at least, several of the inhabitants told me that they never found one dead without some evident cause. The inhabitants believe that these animals are absolutely deaf, certainly they do not hear a person walking close behind them. I was always amused when overtaking one of these great monsters, as it was quietly pacing along, to see how suddenly, the instant I passed, it would draw in its head and legs, and uttering a deep hiss fall to the ground with a heavy sound, as if struck dead. I frequently got on their backs, and then giving a few raps on the hinder part of their shells, they would rise and walk away;—but I found it difficult to keep my balance."

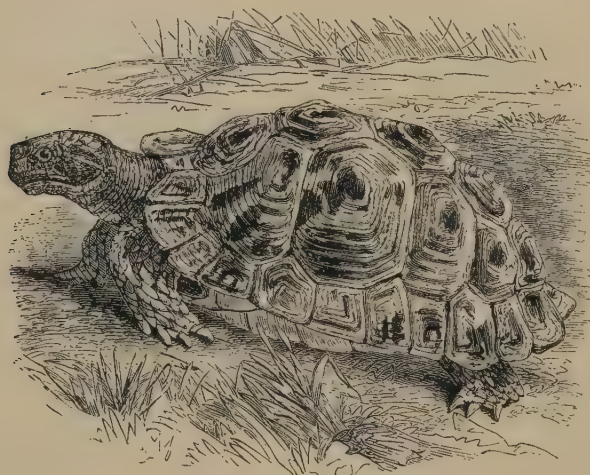
Like their Mascarene allies, the Galapagos tortoises are much esteemed as food; and in order to see whether they were sufficiently fat to be killed, the inhabitants were accustomed to make a slit beneath the tail, through which the interior of the

body could be seen. With the usual hardihood of reptiles, the rejected individuals appear to have recovered completely from this severe operation. From several of the islands the giant tortoises have already disappeared, and it is much to be feared that they will soon cease to exist throughout the Galapagos group. Dr. G. Baur, who visited Albemarle in 1891, reports, however, that he made a large collection of these reptiles, one specimen weighing more than four hundred pounds, and its carapace measuring four feet in a straight line.

Grecian

Tortoise

The familiar Grecian tortoise (*T. græca*) brings us to the sixth main group of the genus, which comprises seven Old-World species of small or medium size, characterized by the carapace being brown or olive, which may be either uniform or spotted with black, or black and yellow; by the gular shields on the plastron being distinct, and by the slight prominence and shortness of the ridge on the palate. The Grecian tortoise belongs to a section of the group in which the anal or hindmost shields of the plastron meet in the middle



GRECIAN TORTOISE.

line by a suture of considerable length, and it is further characterized by the presence of five claws on the fore-foot. From its nearest allies it may be distinguished by the fifth vertebral shield of the carapace being much broader than the third; the caudal shield being usually double, and there being no large tubercle on the inner side of the thigh. The shell of this species is moderately vaulted, and not much expanded behind, while its margins are not serrated. The nuchal shield is very long and narrow; in the male the

divided caudals are much incurved, and the shields of the back show a strongly-marked concentric striation. In color, the shell is bright yellow, with the shields of the carapace spotted and bordered with black, and a broad band of black running along each side of the plastron. The length of the shell is about five and one-half inches. Mainly a South-European species, the Grecian tortoise inhabits the Belearic islands, Corsica, Sardinia, Sicily, Italy, Dalmatia, the Balkan Peninsula, and the Greek Archipelago, while it also occurs in Syria. The allied but larger Algerian tortoise (*T. iberica*), in which the shell attains a length of about nine inches, may be distinguished by the fifth vertebral shield being not broader than the third, by the single caudal shield, and the presence of a large subconical tubercle on the inner surface of the thigh. In color, this species differs from the last in having the plastron more or less spotted with black, while in some examples the carapace is uniformly brown. Its range includes Northwestern Africa, Syria, Asia

Minor, Transcaucasia, and Persia. A third species often represented among the shiploads of these reptiles exported to England, is the margined tortoise (*T. marginata*), which attains a length of eleven inches, and appears to be confined to Greece. The absence of an enlarged tubercle on the thigh serves to distinguish it from the preceding species, from which it also differs by the longer and more depressed shell, in which the hinder margin is much expanded, and more or less serrated. Usually the carapace of the adult is black with a small yellow or greenish spot on each shield; while the ground color of the plastron is yellowish, each of its shields being marked by a black patch, which generally takes a triangular form. This species appears to be confined to Greece; but in Lower Egypt and Syria is replaced by the smaller Leith's tortoise (*T. leithi*), in which the carapace is relatively shorter and more deeply notched in front, while the form and arrangement of the tubercles on the fore-limb is different.

All these tortoises appear identical in their habits, frequenting dry and sandy places, and being extremely fond of sunshine, in which they will bask by the hour together. In certain parts of Greece and the south of Italy, the Grecian tortoise is found in great numbers, and in the markets of Sicily and Italy it is regularly exposed for sale as an article of food. At the approach of winter it buries itself deep in the earth, where it remains during the cold months, usually reappearing in April, but in Sicily as early as February. Although its main food consists of plants and fruits, it will likewise consume such snails, worms, and insects as it may meet with during its wanderings. In captivity, where they have been known to live for a great number of years, these tortoises display great partiality for milky plants, such as lettuce; and they are always fond of a bath. At the approach of rain they always hide themselves, but in fine weather remain abroad throughout the day. In excavating a burrow for the winter's sleep, the earth is dug up by the strong fore-limbs, and thrown out from the hole by the hinder pair. The pairing season commences immediately after the awakening from the winter sleep, and in May or June the female lays from eight to fifteen hard-shelled white eggs, of about the size of a hazelnut. These are deposited in a hole in the earth in some sunny spot, and after being carefully covered up, are left to hatch. By September the young tortoises are about the size of half a walnut shell and present an exceedingly comic appearance.

Other Species There are certain other species belonging to the same group as the Grecian tortoise, which demand a brief notice. Among these is the handsome elongated tortoise (*T. elongata*) from Bengal, Burma, Cambodia, and Cochin China, taking its name from the great length of the depressed shell of the males; the females being much smaller, with a relatively-shorter and wider shell. These tortoises differ from the European species by the anal shields of the plastron having a very short line of union in the middle, even if they meet at all. The ground color of the shell is greenish yellow, upon which is an irregular black patch in each shield, which may occupy nearly the whole area of such shields, leaving merely a narrow yellow margin, or may be much broken up and indistinct. The male attains a length of between ten and eleven inches. Forsten's tortoise (*T. forsteni*) from Celebes and Gilolo may be distinguished by the want of a nuchal

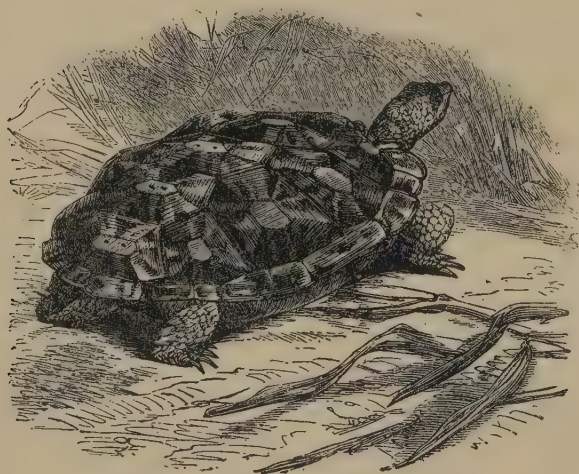
shield in the front of the carapace. Lastly, we have Horsfield's tortoise (*T. horsfieldi*), which, while allied to the European species, differs in having but four claws on the fore-, as well as on the hind-feet. This tortoise inhabits the deserts, oases, and even mountains of Central Asia, where it ranges from the Aralo-Caspian region and the Kirghiz steppes to Afghanistan. The shell, which is considerably depressed and not much longer than broad, has a brown or olive ground color above, which may be either uniform or blotched with black; while beneath, it has large patches of black, which sometimes almost cover the whole surface.

Writing of the elongated tortoise, Dr. J. Anderson says that it is active in its habits, and that the male is very confiding, eating readily from the hand, although the female, when touched, at once withdraws within the shell. Captive specimens were observed to be very restless at night; they feed freely on plantains, but a female on occasion ate some dead prawns and fish, which had been procured to feed some soft tortoises. Horsfield's tortoise, although equally fond of immersing its lower shell in water, is said to be more brisk in hot weather than are the European species; it is purely diurnal in its habits, not venturing forth till after sunrise, and retiring to rest before sunset. Its food in the wild state is stated to be entirely of a vegetable nature; snails and worms being never eaten.

The angulated tortoise (*T. angulata*) of South Africa, together with an allied species (*T. yniphora*) from an island near the Comoros constitute the last and seventh group of the genus, and are distinguished from all the others by the great prolongation of the anterior extremity of the plastron, which is covered by a single gular shield only. The former attains a length of about seven and one-half inches, and has an elongated and very convex carapace,

of which the hinder margin is at most but slightly serrated. In color, the shell is yellow above, each shield being bordered with black, and usually ornamented with a black spot in the centre; while the plastron is black in the middle, or has some large black blotches.

Nearly related to the true tortoises, with which it agrees in the general structure of its shell, the areolated tortoise (*Homopus areolatus*) of South Africa, together with three other allied species from the same continent, differs by the absence of the



AREOLATED TORTOISE.

median ridge on the front of the palate characterizing all the former, and is on this account referred to a distinct genus. If the horny shields be stripped from the carapace, it will be found that the underlying neural bones, instead of being alter-

nately octagonal and quadrangular, are irregularly hexagonal, with the shorter of the two lateral surfaces placed posteriorly; since, however, the same feature occurs in some of the true tortoises, it is not absolutely characteristic of the genus. The areolated tortoise is a small species, with a shell of only four inches in length. It is characterized by having only four claws on the front feet, and by its depressed carapace, which is of equal width throughout, and has even margins. On the back, the shields are more or less inflated, and separated from one another by deep channels; the centre of each shield having a depressed areola, surrounded

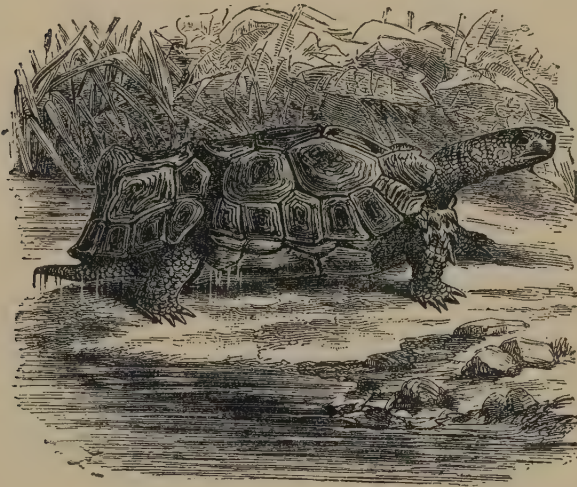


DENTATED HINGED TORTOISES.
(One-fourth natural size.)

by concentric grooves. In color, the carapace is olive, with a reddish-brown centre to each shield; while the plastron is brown in the middle, and yellow at the edges. A second species (*H. femoralis*) differs by having the hinder margin of the shell serrated, and a conical tubercle on the hinder surface of the thigh; while in a third (*H. signatus*) there are five toes on each fore-foot. Lastly, *H. nogueyi* differs from all the others in its vaulted carapace, which is gibbose behind; this species being from Senegal, while the other three are South African. In general habits it is probable that the members of this genus closely resemble the true tortoises.

Hinged
Tortoises

Three remarkable tortoises inhabiting tropical Africa constitute a genus distinguished at a glance from the other members of this section of the family by the circumstance that the hinder portion of the carapace is articulated to the anterior moiety by a ligamentous hinge, upon which it is freely movable, so that when the animal is withdrawn the hinder extremity of the shell can be completely closed. This hinge runs between the fourth and fifth costal bones and the seventh and eighth marginals of the shell. The skull agrees with that of the preceding genus, in the absence of a median ridge on the front of the palate, while the neural bones of the carapace are hexagonal and short sided behind, and the caudal shield is undivided. The costal bones of the carapace differ, however, from those of the tortoises before described, in being of nearly equal width throughout, instead of alternately narrow at one end and broad at the other. Of the three species of the genus, the dentated hinged tortoise (*Cinixys erosa*) from Guinea and the Gabun is characterized by the front and hind margins of the carapace being everted and strongly dentated; by the absence of a nuchal shield, the projection of the extremity of the plastron in front of the carapace, and the sloping contour of the hinder extremity of the latter. The length of the shell is nine inches; its general color above being dark brown, with lighter centres to the shields, and the lower sides of the costal shields yellowish; while on the plastron the shields have dark brown centres and yellowish margins. In the nearly allied Home's hinged tortoise (*C. homeana*) from the same regions there is a nuchal shield, the extremity of the plastron does not project in advance of the carapace, and the hinder extremity of the latter descends vertically. On the other hand, in Bell's



BELL'S HINGED TORTOISE.

hinged tortoise (*C. belliana*), which ranges right across tropical Africa, the margins of the carapace are neither everted nor serrated; a nuchal shield being present on the front of the carapace. In length the latter does not exceed seven and one-half inches.

In habits the hinged tortoises show a complete transition from the land tortoises to the terrapins, and thus fully justifies the conclusion, arrived at from structural considerations, that both groups should be included in a single family.

According to the observations of Monteiro, it appears that Bell's hinged tortoise is essentially a land reptile, inhabiting regions formed of gneiss rocks or other dry localities, where it is active during the hot rainy season, but in the cooler portion of the year, from May to October, according to native reports, lies deeply buried in the earth. Both the

other species, on the contrary, seem to be mainly aquatic in their habits; the den-tated hinged tortoise, which is fairly common in Guinea, being stated to spend a large portion of its time in the water, where one specimen remained for upward of a month. According to Falkenstein, it is found in rivers, even close to the sea, from whence it emerges to lay its eggs on their banks. In spite of its club-like feet, it dives and swims with facility; captive examples descending to the bottom of a deep vessel in which they were kept. On land, its motions are, however, slow and deliberate in the extreme, and have been compared to those of the minute hand of a clock. Its food is of a vegetable nature; one captive specimen displaying great partiality for cherries. By the inhabitants of Guinea these tortoises are eagerly sought after as food, and are thus difficult to obtain by Europeans.

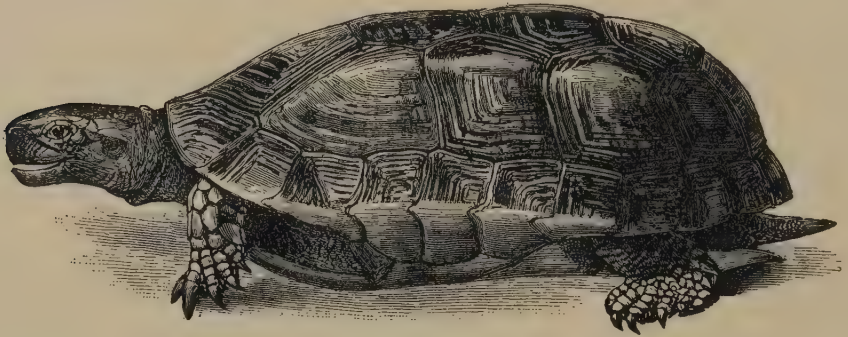
The last member of this section of the family is the spider tortoise (Spider Tortoise) (*Pyxis arachnoides*) of Madagascar, which is the sole representative of a genus characterized by the presence of a transverse hinge across the front of the plastron, by which means the anterior lobe of the latter can be bent upward so as to close the front of the shell. In having the neural bones of the carapace alternately octagonal and tetragonal, this species approaches the true tortoises nearer than do the hinged tortoises. In length the shell is only just over four inches; its coloration is yellow, with radiating black bands from the centres of the shields of the back.

The whole of the tortoises hitherto described are collectively characterized by the absence of all trace of webbing in the toes, by the presence of not more than two joints, or phalanges in each toe, by the metacarpal bones of the fore-foot being but slightly, if at all, longer than wide, and also by the majority of the bony neural plates of the carapace being hexagonal, with their shorter lateral surfaces posteriorly placed, or alternately octagonal and tetragonal. On the other hand, in the remaining members of the family, the digits are usually furnished with webs, or at least a rudiment thereof, while the middle toe of each foot has three joints, and the metacarpal bones are elongated. We have first to deal with a small group, mainly confined to the Oriental region, which both in structure and habits tends to connect this section of the family with the preceding one. These forms, as shown in the right-hand figure of the illustration on p. 2399, agree with the hinged tortoises in that most of the hexagonal neural plates of the carapace have the shorter of the two lateral surfaces placed posteriorly and the longer anteriorly. Moreover, if the horny shields from the plastron be removed, it will be found that the entoplastral, or median unpaired bone of that part of the skeleton, is crossed by the groove marking the boundary between the humeral and pectoral shields.

The spinose land terrapin (*Geoemyda spinosa*) may be taken as a well-known example of the first genus, characterized by the absence of a hinge in the plastron and of a bony temporal arch on the sides of the skull. The three species of this genus are large-sized tortoises, confined to Burma and the Malayan region; the spinose land terrapin having a shell of eight inches in length, while that of the great land terrapin (*G. grandis*) from Burma and Siam measures upward of sixteen inches. In the former of these two species

both the front and hinder margins of the shell are deeply serrated; whereas in the latter, as well as in the third representative of the genus, only the hinder border is thus ornamented. The color of the carapace in these terrapins is brown or blackish, frequently with darker markings. Together with the other members of the group, they differ from the majority of the terrapins in having the head covered with a continuous skin, instead of with small shields. The small size of the webs of these terrapins indicates that in habits they are probably in part aquatic and in part terrestrial.

The Chaibassa terrapin (*Nicoria tricarinata*) figured in the illustration below, and taking its name from a district in Bengal, is selected to represent a genus common to the Oriental region in the east, and Central and South America in the west, distinguished from the preceding by the presence of a bony temporal arch to the skull. Of the seven species of this genus, the smallest (here figured) has a shell of only five inches in length, but in a larger one it may measure as much as sixteen inches. While in the figured Chai-



CHAIBASSA TERRAPIN.
(Two-thirds natural size.)

bassa terrapin both fore and hinder margins of the shell, as shown on the left-hand figure on p. 2399, are entire, in other species either one or both of these may be deeply serrated. The Chaibassa species, which ranges from Bengal to Assam, has the carapace dark brown or black in color, with the three longitudinal ridges from which it takes its name yellow; the plastron being uniformly yellow and the neck and limbs blackish. From the larger three-keeled terrapin (*N. trijuga*) of India and Burma, this species is further distinguished by its more convex shell, which descends very abruptly behind, as well as by the rudimentary condition of the webs between the toes; on both of which grounds it may be regarded as more exclusively terrestrial in its habits. A fossil shell of the Chaibassa terrapin, represented in the right figure on p. 2399, has been obtained from the Pliocene rocks of the Siwalik hills of Northern India, thus indicating the extreme antiquity of the species. In some individuals the hinder half of the plastron is connected with the upper shell merely by ligament.

The third genus of this group (*Cyclemys*), which is confined to India, Malayana, and the south of China, is represented by some half-dozen species, which,

Hinged Terrapins while agreeing with the members of the foregoing genus in the presence of a bony temporal arch to the skull, differ by having a well-marked transverse ligamentous hinge across the middle of the plastron, whereby its hinder lobe is rendered movable and capable of more or less completely closing the posterior aperture of the shell. None of the species have a shell of more than eight inches in length. The genus may be subdivided into two groups, each containing three species. In the former, as represented by *C. dhori* of Northern India and the Malayan region, the plastron, which is notched behind, cannot completely close the shell; while the hinder margin of the carapace is serrated. In the second group, on the other hand, of which the Amboyna hinged terrapin (*C. amboinensis*) is a familiar example, the plastron is capable of completely closing the hinder aperture of the shell, while the posterior margin of the carapace is not serrated. These species also have the shell keeled on the back in the young state. In the Amboyna species, as also in *C. flavomarginata*, the hinder end of the plastron is entire, although in a third (*C. trifasciata*) it is notched.

Box Tortoises Agreeing with the hinged terrapins in the presence of a transverse ligamentous hinge across the middle of the plastron, by the aid of which the openings of the shell can be closed, the two North-American species of box tortoises, together with all the remaining members of the family, differ from the former in that the hexagonal neural bony plates of the carapace have the shorter of their two lateral surfaces placed anteriorly, instead of posteriorly, this arrangement being shown when the shell is stripped. The presence of the hinge in the plastron serves to distinguish the box tortoises from all the members of the second group, with the exception of the pond tortoises, while from the latter they are separated by the beak being hooked and the absence of a bony temporal arch to the skull. In the box tortoises the head is covered with smooth skin above, the toes having only a rudimental web, and the tail is short. The Carolina box tortoise (*Cistudo carolina*) is a somewhat variable species as regards size, the length of the shell ranging from a little over four to somewhat more than five inches. The highly convex carapace is almost hemispherical in shape and is attached to the plastron solely by ligament, so that the whole shell can be completely closed. As a general rule, the upper shell is dark brown or blackish with yellow spots, or brownish yellow with dark brown spots or rays, while there may be an interrupted yellow streak down the middle of the back. The plastron may be either a uniform dark brown or blackish, or may have irregular yellowish blotches on a ground of the same, while in some instances it is yellowish with dark blotches of variable size. The range of this species embraces the Southern and Southeastern United States and Mexico. In the ornate box tortoise from Nebraska and some neighboring states, the shell is more depressed, and the plastron and carapace are connected by a very short bony bridge, so that the shell cannot be completely closed. The toes, moreover, have no distinct webs.

The vaulted carapace of the box tortoises, with their abruptly descending hinder profile, together with the rudimentary condition of the webs of the toes, at once proclaim the terrestrial habits of these reptiles, which form, indeed, one of the connecting links between the true tortoises and the fresh-water terrapins. Although

mainly, if not entirely carnivorous (as is indicated by the absence of a median ridge in the front of the palate), the box tortoises appear to resemble the true tortoises very closely in their general mode of life. According to some observers, they are more frequently to be met with in dry and even hilly districts than in swamps. They are, however, partial to spots where colonies of night herons are in the habit of nesting, owing to the quantity of insects, snails, worms, and fragments of fish to be met with in such localities, and they are frequently found in woods where the ground is either moist or swampy. At times they will, however, enter the water of their own free will, and they have been seen half buried under loose earth or moss in search of worms and insects. Unlike most members of the family, the box tortoises shun the



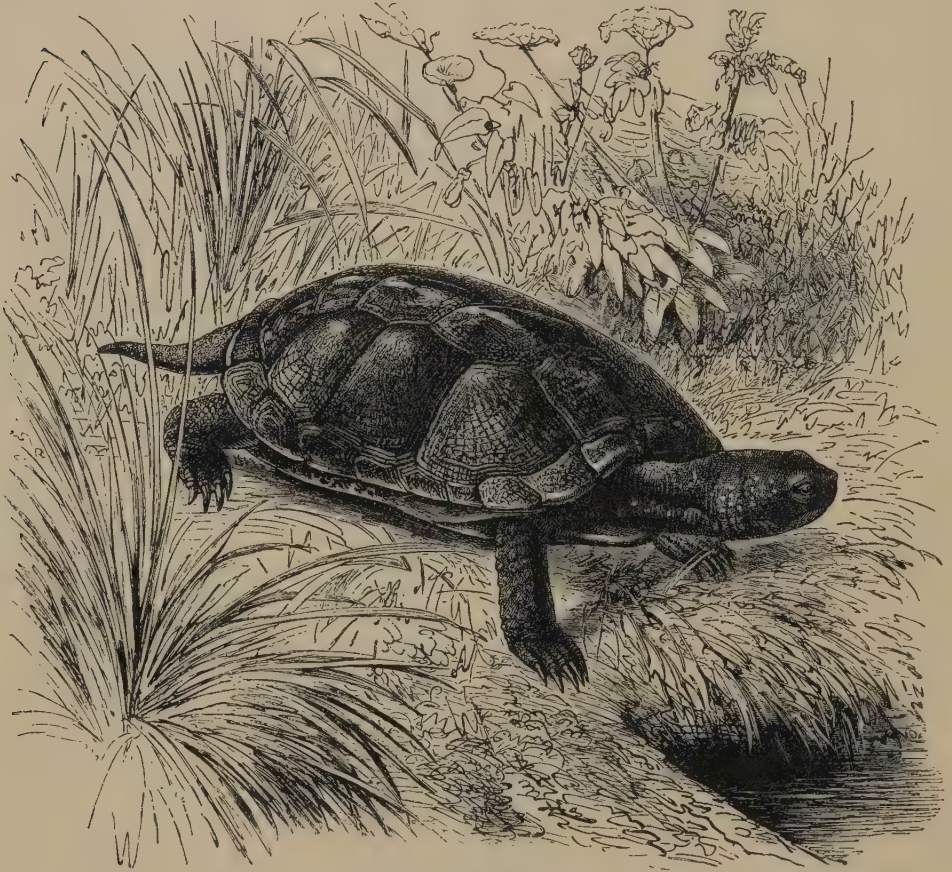
CAROLINA BOX TORTOISE.
(One-half natural size.)

light, and are most active during the evening and night, shutting themselves closely up in their shells when the sun is shining brightly. The closure of the shell is also effected at the approach of any large animal, and when thus securely boxed up, there are but few creatures these tortoises need fear. Like most other terrestrial tortoises, the females lay their eggs in holes dug in the ground by themselves; the number laid being usually only five or six, whether the parents be half grown or adult. Each individual egg is carefully covered with earth; the time taken before the young are hatched being said to vary from eighty-eight to one hundred days. When first hatched, the young are well developed and of great relative size

and strength; although their shells are still soft and cartilaginous, and the remnant of the yolk sack depends from the plastron. In Pennsylvania both young and old bury themselves deep in the ground about the middle of October, where they remain till the latter part of April; the spot selected having a dry soil, and being protected from the cutting blasts of the north. Many individuals which have not buried themselves sufficiently deep, are, however, frozen to death during the winter slumber. On account of the strong and disagreeable flavor of their flesh, doubtless engendered by the nature of their food, the box tortoises are not eaten.

In marked contrast to the vaulted and abruptly-descending carapace of the box tortoises, is the depressed and shelving shell of the pond tortoises, this difference indicating a distinction in the habits of the two genera. Thus whereas the box tortoises are, as we have seen, mainly land reptiles, the pond tortoises are as decidedly aquatic in their mode of life. In addition to the difference in the form of the shell, the members of the present genus are readily distinguished from those of the last by the beak not being hooked, and by the presence of a bony temporal arch in the skull. In the shell the carapace is united to the plastron solely by a ligament, while the plastron itself is more or less distinctly divided by a ligamentous transverse hinge, upon which its two lobes are movable. Agreeing with the box tortoises in having the top of the head covered with undivided skin, the pond tortoises differ by having the toes fully webbed, and also by the more elongated tail, which, while very long in the young, is of moderate length in the adult. Although the genus *Emys* was formerly made to include many of the fresh-water terrapins, it is now restricted to the European pond tortoise (*E. orbicularis*), and a nearly-allied North-American species. The former, which is familiar to most visitors to Southern Europe, is characterized by the short oval form of its carapace, which is widest posteriorly, and in the young state has a more or less distinct median keel. In color, the upper shell of the adult is dark brown or black, ornamented with a variable number of light, usually yellow, dots or radiating streaks, the plastron being either yellow, brown and yellow, or almost wholly blackish brown. In the young, however, the upper shell is dark brown, and the lower black, all the shields of the latter, as well as the marginal ones of the former, having a large yellow spot. The skin of the head, neck, body, and limbs is marked with yellow and black in varying proportions, the head of the male having brownish dots on a darker ground, while in the female the dots are yellow. When fully grown, the shell attains a length of seven and one-half inches, but in most of the specimens exported to England it is not much more than half that size. At the present day the pond tortoise is found, in suitable localities, in South and East Central Europe, and Southwestern Asia as far as Persia, and in Algeria. During the Pleistocene period, when the climate of Northern Europe must at certain times have been much more genial, the pond tortoise had a much more extensive distribution, its fossilized remains having been found in the superficial deposits of Belgium, Denmark, Germany, Lombardy, Norfolk, Sweden, and Switzerland. The American species, which inhabits the Northeastern United States and Canada, has the carapace rather more elongate, and the tail shorter, the former being black with pale yellow or brownish circular spots, and the plastron yellow with a large black patch on each shield.

The European species inhabits both stagnant and running waters, and may be found alike in slow or swift-flowing streams, or in open lakes. During the daytime it leaves the water to bask in the sun on sequestered spots of the banks, where it remains without moving by the hour together, but towards sunset it begins to move, and remains active throughout the night. At the commencement of winter it constructs an underground chamber, in which it remains buried in slumber till spring, usually reappearing, if the weather be favorable, about the middle of April, at which



EUROPEAN POND TORTOISE.
(Two-fifths natural size.)

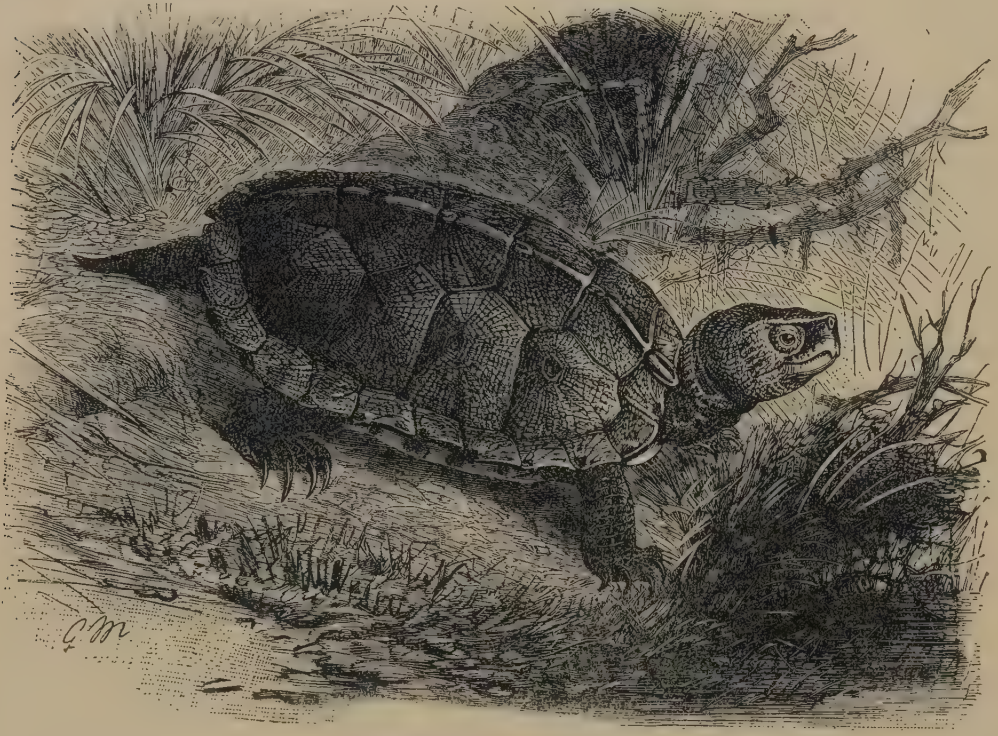
time it reveals its whereabouts by a peculiar whistling cry characteristic of the breeding season. An excellent swimmer and diver, the pond tortoise disappears beneath the water at the slightest sound, while when on land its motions are far more active than those of the true tortoises. Agreeing with other carnivorous terrapins in the absence of a median ridge on the fore-part of the palate, this tortoise feeds chiefly upon worms, water insects, crustaceans, frogs, newts, tadpoles, and fish. In devouring fish they reject the air bladder which floats on the surface of the water; and from the number of such floating air bladders some idea may be formed as to

whether a pond is numerously tenanted by these tortoises. In captivity, where they will live for years, pond tortoises, in addition to their natural food, will readily eat raw meat; and in this state they frequently become so tame as to take food from the hands of their masters. The eggs, varying from nine to fifteen in number, are laid at night during May in hollows dug by the female in dry soil, at a considerable elevation above the bank, where they are carefully covered up and left to develop. These tortoises are eaten by the inhabitants of all the countries in which they occur.

Terrapins The remaining members of this extensive family, which may be collectively known as terrapins, and can receive but brief mention, have the plastron without any transverse hinge, and firmly connected by bone with the carapace, so that the whole shell is solid and immovable. They comprise a large number of species, arranged under eleven genera, and all that can be attempted in a work of the present nature is to select for special notice one or more species of such genera. Although many of these terrapins are exceedingly unlike one another externally, yet they are all so closely connected that the genera can only be distinguished by the characteristics of the skull and the bony plates of the shell, so that our description must of necessity be somewhat technical.

Sculptured Terrapin The sculptured terrapin (*Clemmys insculpta*) of Eastern North America is selected as a fairly well-known representative of a genus of eight species. This genus, it must be premised, forms one of a group of four agreeing with the two last noticed in the absence of a longitudinal ridge on the fore part of the palate, and in the carnivorous habits of its various members. From the three allied genera, *Clemmys* may be distinguished by the aperture of the inner nostrils in the skull being situated between the eyes, by the unpaired entoplastral bone of the lower shell being traversed by the groove formed by the junction between the humeral and pectoral shields, and by the upper part of the head being covered with a continuous smooth skin. The figured species belongs to a group of five, characterized by the median union of the anal or hindmost shields of the plastron being longer than that between the femoral shields; and while four species of this group are confined to North America, Beale's terrapin (*C. bealei*) inhabits China, thus showing a distribution analogous to that of the alligators. On the other hand, the Caspian terrapin (*C. caspica*), ranging from the Caspian Sea to the Persian Gulf, the Spanish terrapin (*C. leprosa*) of Spain and North-western Africa, and the Japanese terrapin (*C. japonica*) resemble one another in having the median union of the anal shields shorter than that of the femorals. The sculptured terrapin, which attains a length of about seven inches, is specially characterized by the toes being webbed only at their bases, by the upper jaw having a notch in the middle, on the sides of which are a pair of tooth-like projections, and by the serration of the hinder border of the carapace. The shell is much depressed, with a raised keel down the middle of the back, and the shields of the carapace ornamented with the radiating and concentric striæ from which that species takes its name. While the ground color of the carapace is blackish, the radiating lines are yellow, the plastron being yellow, with a large black blotch on each of its shields. The soft parts are dark brown or olive, the sides of the head being speckled with red. The figured species is exceedingly abundant on the Atlantic

side of the United States, from Maine to Pennsylvania and New Jersey. Frequenting both marshes and rivers, it leaves the water for much longer periods than its European congeners, and is sometimes found for months at a time in perfectly dry places. In wandering from one stream to another, it makes regular tracks through the woods, and is hence frequently termed in America the wood terrapin. In its feeding and general mode of life, this terrapin presents no features distinguishing it from other carnivorous kinds.



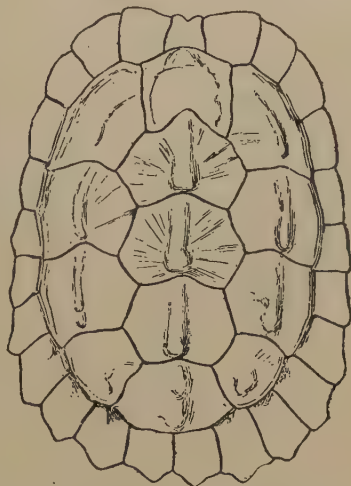
SCULPTURED TERRAPIN.

(Two-fifths natural size.)

Nearly allied to the preceding is the thick-necked terrapin (*Bellia* *crassicolis*) from Tenasserim, Siam, the Malay Peninsula, and Sumatra, which, with a second species from Borneo, constitutes a genus distinguished by the greater development of the bony buttresses connecting the upper with the lower shell, and by the hinder part of the head being covered with small horny shields. The feet are fully webbed, and the anterior vertebral shields of the carapace are more or less distinctly balloon shaped. The typical species measures rather more than six and one-half inches in length, and is of a general dark brown or black color, usually with some yellow markings on the plastron, and some large spots of the same color on the head. Several representatives of this genus are met with in a fossil state in the Pliocene deposits of Northwestern India.

Hamilton's
Terrapin

The handsomely-colored Hamilton's terrapin (*Damonion hamiltoni*) from India, conspicuous for its black and yellow, highly vaulted, and three-keeled carapace, is the best-known representative of a third genus, distinguished from the foregoing by the hinder aperture of the nostrils opening behind the line of the eyes, and the great breadth of the palate. Like the two preceding genera, the entoplastral bone of the plastron is traversed by the groove formed by the union between the humeral and the pectoral shields; and the hinder part of the head is covered with small shields. Hamilton's terrapin has the elevated carapace marked with three interrupted longitudinal keels, or rows of nodose prominences; the color of the shell being dark brown or blackish, upon which are spots and streaks of yellow, and the soft parts having likewise a similar coloration. While in young individuals the hinder border of the carapace is strongly serrated, in the adult it becomes nearly smooth. This species attains a length of nearly nine inches at the present day, but fossil examples found in the Pliocene rocks of Northern India were still larger. These fossil specimens lived with numbers of mammals belonging entirely to extinct species. There are four other species of the genus ranging over Malaya, Southern China, and Japan.



UPPER SURFACE OF CARAPACE OF
HAMILTON'S TERRAPIN.

Salt-Water
Terrapin

The last representative of the group with a smooth palate and carnivorous habits is the North American genus *Malaclemmys*, distinguished from the last by the head being covered with continuous skin, and by the groove formed on the plastron by the junction between the humeral and pectoral shields being situated in advance of the entoplastral bone. While two of the species inhabit the valley of the Mississippi, the salt-water terrapin (*M. terrapin*) is a frequenter of the salt marshes of the Atlantic coast. The latter has an oval and much depressed carapace, which attains a length of nearly seven inches, and is characterized by the great width of the first and second vertebral shields; its general color being either olive, with black concentric lines, or uniform blackish. The plastron is yellowish or reddish, with variable black markings.

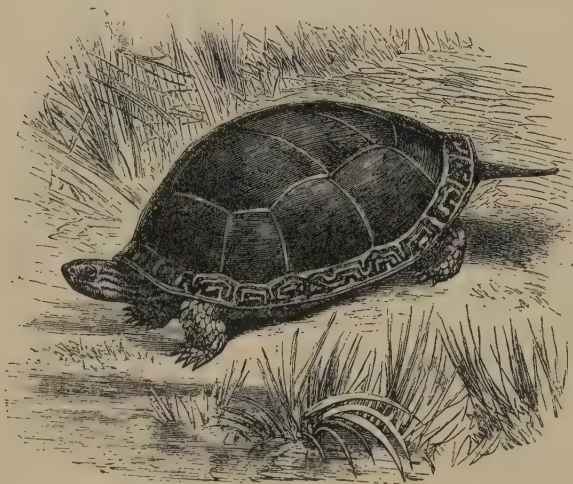
It is this species that generally forms the celebrated New York dish known as terrapin; but it would seem that other species are also used, as the following account refers to terrapins taken high up the rivers. The best terrapins go by the name of "diamond backs," and do not generally exceed some seven inches in length, although they may rarely measure as much as ten inches, but all terrapin of larger dimensions belong to the inferior kinds, ordinarily designated "sliders." According to Mr. W. M. Laffan, "terrappin are caught all the way from Savannah and Charleston to the Patapsco river at Baltimore, but the genuine diamond back belongs only to the Upper Chesapeake and its tributaries. The majority of the

sliders are brought to Baltimore from the James river. The terrapin catchers make from five to twenty dollars per week, and they find the reptile or 'bird,' as the *bon vivant* calls it, by probing the mud in the shallows with sticks. The terrapin is dormant, and when found is easily secured. A four-pound terrapin taken about September 15 will exist prosperously in a dark, cool place, without food or drink, until April 15, and (the dealers say) will gain two ounces in weight. After that time it gets lively and active, and will take hold of a finger with great effusion and effectiveness. The male terrapin is known as a 'bull,' and the female as a 'cow.' The latter is much more highly prized, and generally contains about thirty eggs. No dish of terrapin is thought complete without being garnished with these." Formerly caught in shoals, the diamond back has now become very scarce, and is, indeed, in some danger of extermination. The terrapin furnished in hotels is almost invariably "sliders," diamond backs being sold to private houses only.

Painted

Terrapin

The seven remaining genera of the family constitute a distinct group, distinguished from the one including the six genera just mentioned by the circumstance that the broad front portion of the palate of the skull is marked by one or two longitudinal ridges, and likewise by all the species being mainly or exclusively herbivorous in their diet. Among these,



PAINTED TERRAPIN.

the large and exclusively American genus *Chrysemys*, with a dozen species, of which the painted terrapin (*C. picta*) is one of the best known, belongs to a subgroup of three genera, characterized by the bony buttresses connecting the upper with the lower shell being short or of moderate size. From its allies *Chrysemys* is distinguished by the opening of the posterior nostrils being situated between the eyes, and by the entoplastral bone being situated in advance of the groove on the plastron formed by the junction of the humeral

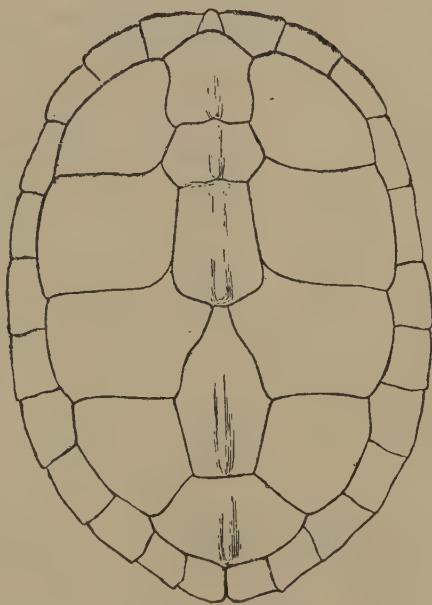
with the pectoral shields. The painted terrapin of Eastern North America, which attains a length of six inches, and has a much depressed shell, takes its name from its brilliant coloration. Thus, the carapace is olive or blackish, with yellow lines bordering the shields, and its marginal shields red, with black concentric or crescentic markings; while the plastron is yellow, sometimes with small streaks of black on the middle line, and the bridge red, with black markings. The soft parts have a brown or blackish ground color, with lighter bands, which are yellow on the head and red elsewhere.

**Eyed and
Chinese
Terrapins**

The eyed terrapin (*Morenia ocellata*) from Burma, together with an allied species from Bengal constitute a genus distinguished from the preceding by the aperture of the posterior nostrils opening behind the line of the eyes. The typical species in which the shell measures nearly nine inches in length, takes its name from the eye-like black spots ringed with yellow which adorn each shield of the back portion of the carapace. On the other hand, the Chinese terrapin (*Ocadia sinensis*), which is the sole existing representative of its genus, differs from *Chrysemys* in having the entoplastron intersected by the groove formed by the junction between the pectoral and humeral shields. The genus is of special interest as being represented by extinct species in the upper Eocene strata of the south of England and the Continent.

Batagurs

The remaining members of the family, which are arranged under four genera, and may be collectively known as batagurs, are exclusively confined to India, Burma, and the Malayan region. They comprise the largest fresh-water representatives of the family, and are readily characterized by the great development of the vertical bony buttresses connecting the carapace with the plastron, which project as walls within the shell, so as partially to divide it into compartments. Of the four genera, *Cachuga*, which is represented by seven species from India and Burma, is readily recognized by the great elongation of the fourth vertebral horny shield of the carapace, which extends over four or five of the underlying neural bones. The smaller members, such as Smith's batagur (*C. smithi*) and the black-and-yellow batagur (*C. tectum*), of the Ganges and Indus, are characterized by the fourth vertebral shield terminating in front in a narrow point. Whereas the former of these has a depressed and feebly-keeled shell, the latter, especially when young, has the carapace much vaulted, and the third vertebral shield produced behind into a conical elevation forming the highest part of the shell. The name of black-and-yellow batagur is derived from the irregular black patches on the bright yellow plastron, the carapace being brown. I have taken specimens of this pretty little batagur, which does not exceed eight inches in length and is generally much smaller, near the fort at Calcutta. Like the under-mentioned dhongoka, it occurs fossil in the Pliocene deposits of Northern India. The larger species of the genus, such as the Indian dhongoka (*C. dhongoka*), which grows to over fourteen inches, has the fourth vertebral shield broad in front, instead of being narrowed to a point.



UPPER SURFACE OF CARAPACE OF SMITH'S
BATAGUR.
(Two-fifths natural size.)

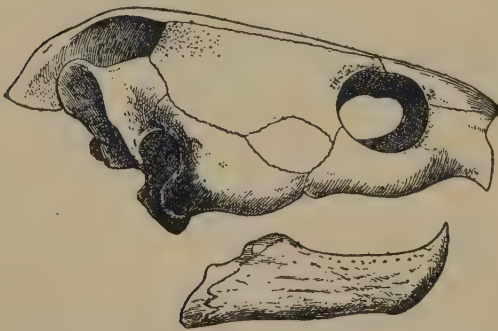
The three remaining genera, *Callagur*, *Batagur*, and *Hardella*, differ from the preceding in that the fourth vertebral shield of the carapace is not longer than the third; but it will be unnecessary to point out the features by which they are severally distinguished. The largest of all is the true batagur (*Batagur basca*) in which the carapace measures upwards of twenty inches in length.

All the batagurs are exclusively vegetable feeders, and the larger species are thoroughly aquatic in their habits, spending by far the greater portion of their time in the water. They abound in the larger rivers of India and Burma, where their huge shells form conspicuous objects as they rise to the surface to breathe. Describing the habits of a captive specimen, Dr. John Anderson states that when it rose to breathe "its nostrils were simply protruded above the surface of the water, and retained in that position for about half a minute, during which it made a long expiration, followed by a deep inspiration, the creature then slowly subsiding, tail backward, to the bottom. The animals, unless they were much irritated, never attempted to bite, but, when so treated, they sluggishly seized any object put in their way, holding it between their jaws with considerable tenacity, at the same time withdrawing the head into the shell. They moved about on the ground with considerable agility, supporting their heavy bodies erect on their legs like a land tortoise." Another species will occasionally snap, when, owing to the friction of its serrated jaws against each other, a peculiar kind of barking sound is produced. Batagurs are eaten in Lower Bengal by some of the inferior castes of Hindus, and are kept for this purpose in tanks.

THE BIG-HEADED TORTOISE

Family *PLATYSTERNIDÆ*

This extraordinary creature (*Platysternum megacephalum*), which is an inhabitant of the south of China, Siam, and Burma, is the sole representative, not only of a very remarkable genus, but likewise of a distinct family, which appears to be to a great extent intermediate between that of the tortoises and that of the snappers. The most peculiar feature about this tortoise is the disproportionately large size of its head, in which the beak is much hooked; and an examination of the skeleton will show that the temporal fossæ of the skull differ from those of all the members of the preceding family in being roofed over with bone, as in the following family of the snappers. Moreover, the tail resembles that of the latter in its great length, and also in the circumstance that the articular surfaces of most of its vertebræ have



SIDE VIEW OF SKULL OF BIG-HEADED TORTOISE.

(From Boulenger.)

the cup behind and the ball in front, whereas in the tortoise family just the reverse of this arrangement occurs. On the other hand, the carapace resembles that of the latter, and differs from that of the snappers in the absence of a rib-like process from its posterior angles passing backward beneath the marginal bones. The carapace is characterized by its extreme depression and oval form, while the plastron is of moderate size, and connected with the carapace solely by a ligament, so that bony buttresses are totally lacking. The head is covered with a continuous horny shield,



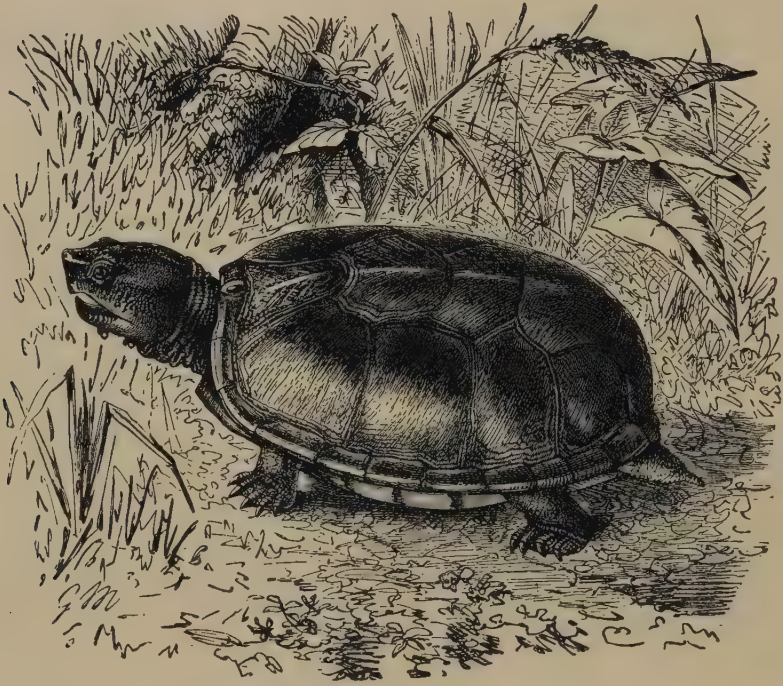
THE BIG-HEADED TORTOISE.
(One-half natural size.)

and the hooked jaws are of great power. The toes are of moderate length, and but slightly webbed; all, save the fifth in the hind-foot, being furnished with claws. The long and cylindrical tail becomes compressed at the end, and is covered with rings of quadrangular shields. In size this tortoise is small, the length of the carapace being only about six inches, and that of the tail some three-quarters of an inch more. In the adult the color is olive brown above, and yellowish brown beneath, but the young is more brilliantly colored. Of the habits and mode of life of this tortoise, nothing appears hitherto to have been ascertained.

THE MUD TERRAPINS AND THEIR ALLIES

Families *CINOSTERNIDÆ* and *DERMATEMYDIDÆ*

The mud terrapins (*Cinosternum*) bring us to the first of two nearly-related families confined to the New World, all of which differ from those previously noticed by the circumstance that the nuchal bone of the carapace gives off from each of its hinder angles a long rib-like process which underlies the marginal bones. From the second family, the mud terrapins, of which there are eleven species inhabiting America north of the Equator, are broadly distinguished (as indeed they are



PENNSYLVANIAN MUD TERRAPIN.
(One-half natural size.)

from all other members of the order) by the fact that there are but eight bones in the plastron, owing to the absence of the unpaired entoplastral bone. As regards their other characteristics, the mud tortoises resemble the *Testudinidæ* in the conformation of the vertebræ of the tail, and in the absence of a roof to the temporal fossa of the skull, as well as in the extreme shortness of the tail. The carapace is more or less depressed, and is articulated by a bony suture with the plastron, the latter having the gular shields fused into one, or wanting, and its fore- and hindlobes more or less movable. The toes are fully webbed, and with the exception of the fifth in the hind-foot, strongly clawed. The best-known representative of the

genus is the Pennsylvanian mud terrapin (*C. pennsylvanicum*), which attains a length of about four and one-half inches, and inhabits Eastern North America from New York to the Gulf of Mexico. In color, the shell is brown or brownish above, and either yellow or brown beneath, the lines of junction between all the shields being dark brown or black, while the head and neck are brown with yellowish spots. From other species of the genus it is distinguished by the large size of the plastron, in which the anterior lobe is narrower than the mouth of the shell.

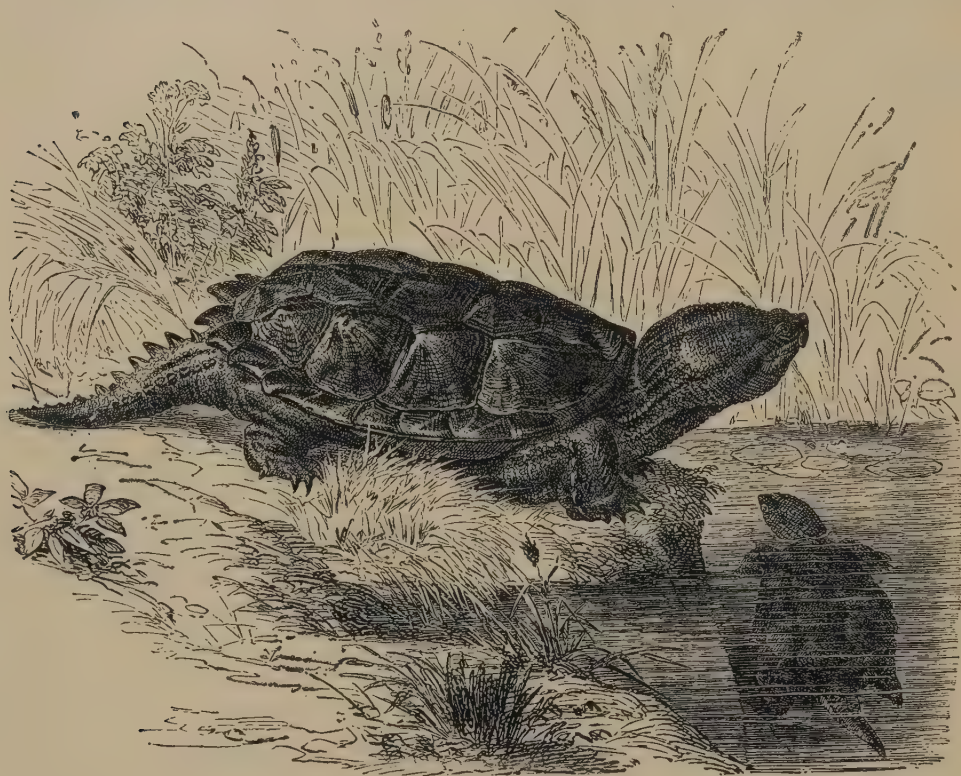
In general habits the mud terrapins seem to be very similar to the fresh-water members of the tortoise family, although they prefer swamps and marshes to running waters. Carnivorous in their diet, they subsist chiefly on small fishes, insects, and worms, while they have been observed to capture newts. They will readily take a baited hook, and when thus caught sink rapidly and heavily to the bottom, thus causing the angler to believe that he has hooked a weighty fish. At the commencement of winter they bury themselves in moss, where they remain dormant till the following May. An extinct genus nearly allied to the mud tortoises occurs in the Tertiary rocks of Baden.

Maw's terrapin (*Dermatemys mawi*) may be taken as a good representative of the second family, all the three genera of which are restricted to Central America. This family connects the preceding one with the snappers, agreeing with the latter in the presence of an entoplastral bone, and with the former in the characteristics of the vertebræ of the short tail, which have the cup in front, and the absence of a roof to the temporal fossa of the skull. Maw's terrapin and its allies further agree with the mud terrapins in the incompleteness of the series of neural bones of the carapace; the hinder ones being wanting, and thus allowing the costal plates to meet in the middle line. Externally, the members of the present family may be distinguished from the *Testudinidæ* by the presence of an additional series of infra-marginal shields between the marginals and those of the plastron—a feature which they possess in common with the big-headed tortoise and the snappers. Maw's terrapin, which attains a length of some fifteen inches, and is the sole representative of its genus, has the plastron large, and connected with the carapace by an elongated bridge, the gular shield being single, and the usual five other pairs of shields being present on the plastron. Unlike most other tortoises, there are twelve pairs of marginal shields in place of the usual eleven. In the other two genera of the family—*Staurotypus* and *Claudius*—the plastron is reduced to a cross-like shape, and has but a short connection with the carapace, while the number of paired shields on the former is only four or three, and the chin is provided with a pair of wattle-like appendages, of which there is no trace in Maw's terrapin. While in the two species of *Staurotypus* the plastron is connected with the carapace by a bony bridge, in the single representative of *Claudius* the junction is entirely ligamentous. This family is represented by several extinct genera in the Tertiary and Cretaceous strata of North America, one of which (*Baptemys*) had the full series of neural bones; and there appear to have been allied forms in the European Tertiaries.

THE SNAPPERS AND ALLIGATOR TERRAPINS

Family *CHELYDRIDÆ*

Resembling the big-headed tortoise in the great relative size of their hook-beaked heads, and their elongated scaly tails, the snapper and alligator terrapins of North and Central America constitute a well-marked family by themselves. In the first place, they differ from the species named in that the nuchal bones give off rib-like processes underlying the marginals; while the temporal region of the skull is but partially covered with a bony roof. The American forms are further charac-



ALLIGATOR TERRAPIN.
(One-twelfth natural size.)

erized by the relatively-small size of the carapace, of which the hinder border is strongly serrated; while the cruciform plastron is likewise small, and but loosely articulated with the upper shell by a very narrow bridge. Moreover, both the upper and lower shells are not completely ossified till very late in life, vacuities remaining for a long time between the costal and marginal bones in the former, and in the middle line of the latter. Then, again, the plastron is peculiar in that the abdominal shields, which are separated from the marginals by an inframarginal series, do

not meet one another in the middle line, although they may be connected by some small, irregular, unpaired additional shields. Further, the enormous head cannot be completely retracted within the carapace, of which the anterior margin is deeply excavated in order to afford it room, and the chin is provided with one or more pairs of pendent wattles. With the exception of the fifth in the hind-limb, the toes are furnished with claws, and the long tail is crested above.

Alligator Terrapin The alligator terrapin, or snapping turtle (*Chelydra serpentina*) is a giant among river tortoises, and takes its name from a fancied resemblance to an alligator surmounted by a chelonian shell. It is one of two species belonging to a genus characterized by the eyes being directly upward and outward, so that their sockets are visible in a top view of the skull; by the tail being furnished with large horny shields on its lower surface; as well as by the absence of the supramarginal shields found on the carapace of Temminck's snapper. The carapace, which may attain a length of at least twenty inches, is characterized by its rugose surface, bearing three well-marked tuberculated keels, which tend to become smoother with advancing age; while its vertebral shields are remarkable for their great width. The snout is short and pointed, with a very narrow space between the eyes; the skin is warty, and on the chin is developed into a pair of wattles or barbels. In the young the tail is as long or even longer than the shell, becoming relatively shorter in the adult; its upper surface having a crest of large compressed tubercles, while the shields on the lower surface have been already alluded to. As in the other members of the family, the color is a uniform olive brown. The alligator terrapin inhabits the rivers of North America to the eastward of the Rocky mountains from Canada to Mexico, and is also found in Ecuador. A second living species (*C. rossignonii*), distinguished, among other features, by the presence of four wattles on the chin, is met with in Guatemala and Mexico. Nearly allied to this is a third and extinct species (*C. murchisoni*) from the Miocene rocks of Baden; and as we have already seen that the mud terrapins, and probably also Maw's terrapin, were represented in the Tertiary strata of Europe, it is not improbable that the Eastern Hemisphere may have been the original home of the present group of families.

Temminck's Snapper Attaining considerably larger dimensions than the alligator terrapin, Temminck's snapper (*Macrolemmys temminckii*) is distinguished as a genus by the lateral position of the eyes, the sockets of which are invisible in a front view of the skull, as well as by the presence of three or four additional or supramarginal shields on the sides of the carapace, and by the under surface of the tail being covered with small scales. The triangular head is proportionately even larger than in the alligator terrapin, and the carapace has three very strongly-marked longitudinal ridges. In length, the shell may measure at least a couple of feet, the tail being somewhat shorter. This species inhabits North America from Western Texas to Florida, extending northward to Missouri.

Habits Since the alligator terrapin and Temminck's snapper appear to be very similar in their mode of life, their habits may be treated of collectively. Both these tortoises frequent alike the rivers and larger swamps of the United States, occurring in certain localities in enormous numbers, and most com-

monly in waters that have a muddy bottom, not even disdaining the most malodorous pools. As a rule, they lie in deep water, near the middle of the river or swamp, although at times they show themselves on the surface, where, with outstretched neck, they will float with the current. In populated districts the least sound is, however, sufficient to send them at once to the bottom, although in more remote regions they are less shy. At times they may be observed at considerable distances from the water, probably in search of food or of suitable spots to deposit their eggs. Temminck's snapper well deserves its name, since, from the moment of its escape from the egg, it commences to snap and bite at everything within its reach; and an adult has been known to make a clean perforation with its powerful beak through the blade of an oar half an inch in thickness. When one of these tortoises is taken into a boat, Weinland states that it will rear itself up on its hind-legs, and with lightning-like speed throw itself half a yard forward to bite an oar; and they have been known to inflict terrible wounds on persons who have incautiously entered waters where they abound. In the water the movements of these reptiles are more rapid than those of most of their kin, and when in pursuit of prey they swim with surprising speed. Their food consists largely of fish, frogs, and other water animals, and they will also frequently seize and drag down large aquatic birds, more especially ducks and geese. Tame specimens, that were kept in a pond in the United States, proved terrible foes to the stock of fish contained in the same. The eggs, which vary from twenty to thirty in number, and are about the size of those of a pigeon, are deposited on the ground near the water, and are carefully covered over with leaves. In captivity these tortoises thrive well in Europe, if the water be kept at a sufficiently high temperature; and a specimen of Temminck's snapper, which has lived for more than thirteen years in the Brighton Aquarium, grew to a length of between four and five feet from beak to tail, whereas, on its arrival, it measured less than a foot. In the confined limits of a tank the movements of this reptile were deliberate and sluggish, and gave no idea of the activity characterizing the wild state. Although the flesh of the adult of this species has such a strong musky flavor as to be uneatable, that of the young is stated to be tender and palatable. The eggs are also sought after as articles of food; and when two or three females have laid together, as many as from sixty to seventy may be taken from a single nest.

THE TURTLES

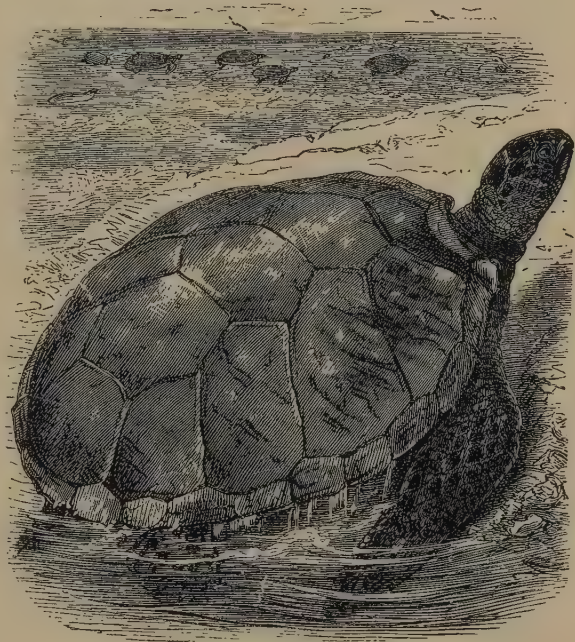
Family *CHELONIDÆ*

The families mentioned up to now have their feet more or less fully adapted for walking on land, and the majority of the toes furnished with well-developed claws or nails, while the carapace is generally of a somewhat oval form. The true turtles, on the other hand, while agreeing with the foregoing in having their shells covered with horny plates, are at once distinguished by the limbs being converted into flattened paddles, in which, at the most, only two of the toes are furnished

with claws. They are further characterized by the heart-like form of the carapace, within which the head can be only partially withdrawn; while the plastron is never united by bone to the carapace, and vacuities remain in the latter between the costal and marginal bones either throughout life, or for a very long period. The skull has its temporal fossæ completely roofed over by bone, and the vertebræ of the very short tail have the articular cup in front and the ball behind. Entirely marine in their habits, and resorting to the shore only for the purpose of breeding, turtles differ from tortoises and terrapins in that the shells of their eggs are soft. In their entire conformation they are admirably adapted for an aquatic life, the body being depressed to facilitate rapid progress through the water, both the skull and shell being of unusually light and porous structure; the limbs form most perfect paddles, capable of propelling the animals with great speed. The head is placed upon the neck in such a manner as to allow of the nostrils being readily raised above the surface of the water for the purpose of breathing, and the nostrils themselves can be hermetically closed by means of a fleshy valve. The three best-known species of turtles, which are assigned to two genera, are inhabitants of all tropical and subtropical seas; one species—the loggerhead—occurring in the Mediterranean, and occasionally wandering northward.

Widely celebrated as being the source of the far-famed turtle soup of civic banquets, the green turtle (*Chelone my-*

das) is one of two species belonging to a genus characterized by the presence of four pairs of costal shields on the carapace, and by the persistence of the vacuities between the costal and marginal bones of the latter throughout life. The plastron is, moreover, distinguished by the presence of an intergular shield between the two gulars; while, as in the second genus, there is a row of inframarginal shields between the marginals and the proper shields of the plastron. The skull is of moderate size in comparison to the shell, with the sockets of the eyes placed nearly vertically, and separated by a broad bar of bone. Such are the characteristics common to the two species of the typical genus of the family. The green turtle is specially distinguished by its short beak which is devoid of a hook at the tip, and by the shields of the carapace being in contact by their edges all through



GREEN TURTLE.

life. In the young, the carapace shows a faint median keel, while its hinder margin is at most but feebly serrated at all ages. Generally there is but a single claw on each paddle, although, in some instances, young specimens also have a claw on the second digit. In color, the shell of the adult is olive or brown, with yellowish spots or marblings; while in the young it is uniform dark brown or olive above, and yellow beneath, the limbs being bordered with yellow on the upper surface, and inferiorly yellow with a brown spot near the extremity. The food of the species consists of seaweeds, especially the seawrack, upon which the turtles graze at the bottom of the water, rising occasionally to the surface to breathe.



HAWKSBILL TURTLES SWIMMING.
(One-twentieth natural size.)

**Hawksbill
Turtle**

Generally rejected as food, the hawksbill turtle (*C. imbricata*) enjoys thereby no respite from persecution, since it is eagerly hunted for the beautifully-mottled horny shields of its shell, which are the sole source of the tortoise shell of commerce. In its young state, the hawksbill may be readily distinguished from the preceding species by the circumstance that the horny shields on the back of the three-ridged shell overlap one another like the tiles on a roof. With advancing age the shields gradually, however, become smooth, and in very old specimens they meet at their edges, as in other members of the order. At

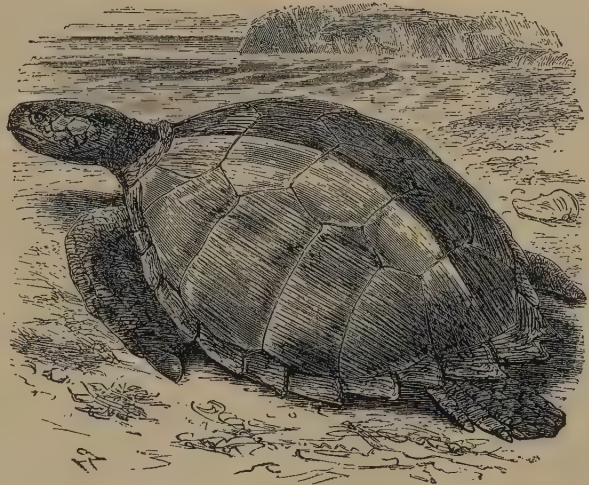
all ages the hinder margin of the carapace is more or less strongly serrated; and the compressed and sharply-hooked beak will always serve to distinguish at a glance a hawksbill from a green turtle. Moreover, the limbs always have two claws. In the adult, the shields of the carapace are beautifully marbled and mottled with yellow and dark reddish brown, while the plastron is yellow, and the shields on the head and paddles are brown with yellow margins. In size this species is somewhat inferior to the green turtle, the carapace attaining a length of about thirty-two inches, against forty-two inches in the latter. In habits the hawksbill differs markedly from the green turtle, being exclusively carnivorous.

**Loggerhead
Turtle**

The third, and probably the largest species of turtle, is the loggerhead (*Thalassochelys caretta*), easily recognized by its enormous head and the presence of at least five costal shields on each side of the carapace, which differs from that of the two preceding species by becoming completely ossified in the adult state. The beak is strongly hooked; and while in the young there are usually two claws to each paddle, one of these frequently disappears in the adult. In color, the adult is brown above and yellowish beneath, but the young is uniformly dark brown or blackish. The Mexican loggerhead (*T. kempi*) from the Gulf of Mexico, differs in having a median ridge on the bone of each jaw, whereas in the ordinary species such ridges are confined to the investing horny sheath. According to Mr. Gosse, loggerheads feed on cuttles and other mollusks, their powerful beaks enabling them to crush strong conch shells as easily as a man can crack a nut.

Habits

Apart from the difference in their food, all turtles appear to be similar in their general mode of life, never leaving the sea except for the purpose of laying their eggs, and then shuffling along in an awkward, ungainly manner. During the laying season they resort to low sandy coasts, especially unfrequented tropical islands, in vast numbers; and if once turned on their backs, while on shore, are unable to right themselves again. This habit of resorting to the land to lay their eggs clearly proves, it may be observed, the descent of turtles from fresh-water members of the order. Writing of the green turtles at Aldabra, one of the Seychelles group of islands, Mr. Spurr remarks that the males permanently frequent the bay of that island, the females when they attain full maturity (twenty or twenty-five years) disappearing altogether. When the latter come to the shore for the purpose of laying, their shells are covered with barnacles of two or three weeks' growth. Commercially,



YOUNG LOGGERHEAD TURTLE.

the females are more valuable than the males, and, as they are more easily captured, the proportion found on the island is one female to every ten males, although, for one of the latter, about ten of the former sex are hatched. Turtles generally come ashore on fine moonlight nights, displaying great caution in landing, and then generally uttering a loud hissing noise which serves to disperse many of their enemies. Once landed, the female turtle, writes Audubon, "proceeds to form a hole in the sand, which she effects by removing it from under her body with her hind flippers, scooping it out with so much dexterity that the sides seldom, if ever, fall in. The sand is raised alternately with each flipper, as with a large ladle, until it has accumulated behind her, when, supporting herself with her head and forepart on the ground fronting her body, she, with a spring from each flipper, sends the sand around, scattering it to the distance of several feet. In this manner the hole is dug to the depth of eighteen inches, or sometimes more than two feet. This labor I have seen performed in the short space of nine minutes. The eggs are then dropped one by one, and disposed in regular layers, to the number of one hundred and fifty, or sometimes nearly two hundred. The whole time spent in this part of the operation may be about twenty minutes. She now scrapes the loose sand back over the eggs, and so levels and smooths the surface that few persons on seeing the spot could imagine that anything had been done to it. This accomplished to her mind, she retreats to the water with all possible dispatch, leaving the hatching of the eggs to the heat of the sand." During a season each female will lay three clutches of eggs, at intervals of from a fortnight to three weeks, usually from one hundred and twenty-five to one hundred and fifty in number. No sooner are the young turtles hatched, than hosts fall victims to land crabs, frigate, and other sea birds, while, when they reach the sea, they are attacked by swarms of predaceous fishes. To escape the latter, the young reptiles allow themselves to be carried out by currents into deep water, where they are less readily seized. During the breeding season the males fight desperately with one another, to the great joy of the sharks, by whom the disabled ones are seized.

When first laid, the round eggs of turtles are never quite full, but before hatching become fully distended. In describing the breeding habits of the turtles kept in a pond near the dockyard in Ascension island, Moseley states that in the breeding season the females dig great holes as large as themselves in a bank of sand, in which to deposit their eggs. The sand in which the eggs are laid does not feel warm to the hand, but during the daytime is rather cool, while it is at all times moist. Its temperature appears to undergo no material variation, owing to the depth at which the eggs are deposited, such medium amount of heat being sufficient for the hatching.

Although a large number of green turtles are captured by being turned on their backs while on shore, in the Seychelles and Bahamas they are harpooned. In Keeling island the method of capture is described by Darwin as follows: "The water is so clear and shallow that, although at first a turtle dives quickly out of sight, yet, in a canoe or boat under sail, the pursuers, after no long chase, come up to it. A man, standing nearly in the bows at this moment, dashes through the water upon the turtle's back, then, clinging with both hands to the shell of the neck, he is

carried away, till the animal becomes exhausted, and is secured." In China and Mozambique turtles are captured by means of sucking fishes, which are taken to a spot where the reptiles are basking upon the surface of the water. Each fish has a ring round its body to which a line is attached, and as soon as it securely fastens itself by its sucking disc to the back of a turtle, both captor and captured are drawn ashore. Although those of the loggerhead have a somewhat musky taste, the eggs of the other species of turtle are much esteemed as articles of food, while all yield a valuable oil.

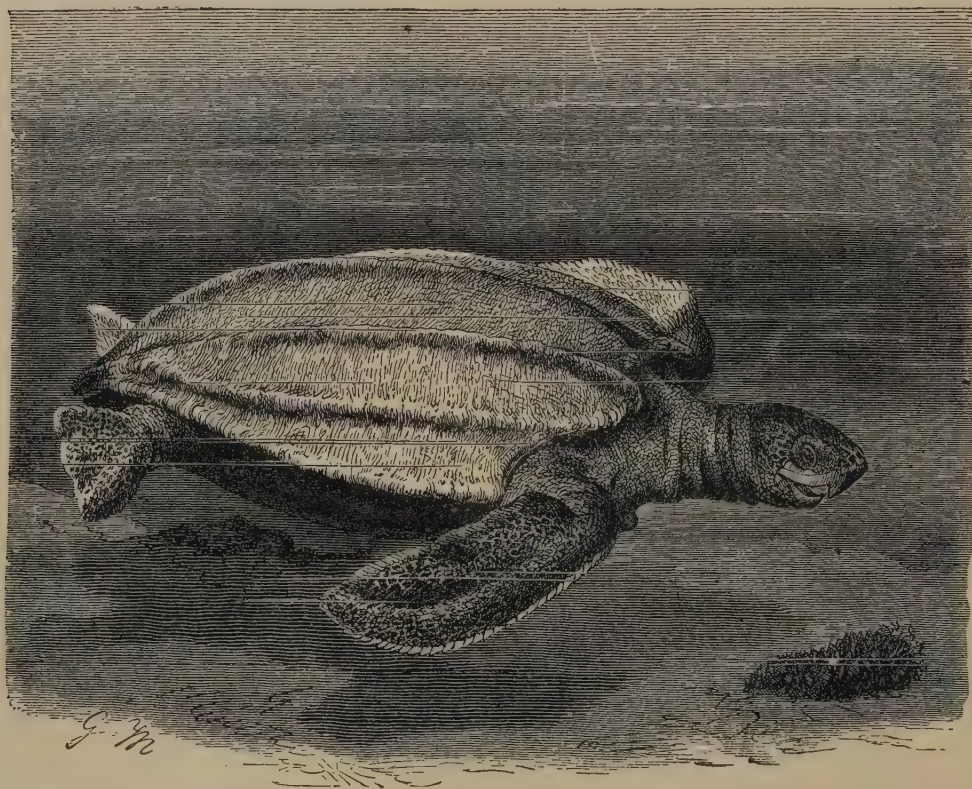
Tortoise Shell As already said, tortoise shell is a product of the hawksbill turtle, and it is too often taken from the back of the living animal by the aid of heat, after which painful operation the unfortunate turtle is returned to its native element. As the raw tortoise shell is very unlike the finished article, with which all are familiar, Bell's brief account of the process of manufacture may be quoted. The horny shields, as removed from the turtle, being highly curved, "the uneven curvature is first of all to be removed, and the plate rendered perfectly flat. This is effected by immersing it in hot water, and then allowing it to cool under heavy pressure between smooth blocks of wood, or metallic plates. The surface is then rendered smooth, and the thickness equal, by scraping and filing away the rough and prominent parts. In this way each plate receives an equal and smooth surface. But it is in many cases desirable to employ larger pieces than can be obtained from single plates, and two pieces are then united in the following manner: The edges are beveled off to the space of two or three lines, and the margins, when placed together, overlap each other to that extent. They are then pressed together by a metallic press, and the whole is submitted to the action of boiling water; and by this means the two pieces are so admirably soldered together as to leave no indication of the line of union. By the application of heat, also, the tortoise shell may be made to receive any impression by being pressed between metallic molds." Necklaces, etc., are made by pressing the fragments and dust in molds.

Extinct Turtles Turtles, more or less closely allied to the existing kinds, abound in marine strata of the Tertiary and Cretaceous epochs, some belonging to extinct and others to the living genera. Among the latter, the gigantic Hoffmann's turtle (*Chelone hoffmanni*) from the chalk of Holland appears to have been allied to the hawksbill, but had a shell of some five feet in length. Extinct loggerheads occur in the London Clay; and an allied extinct genus (*Lytoloma*), common to the same formation and the upper Cretaceous deposits, was remarkable for the great length of the bony union between the two branches of the lower jaw, and also for the circumstance that the aperture of the internal nostrils was placed right at the hinder extremity of the palate as in crocodiles. In strata older than the Chalk, such as the Purbeck and other Oölitic rocks, we meet with turtles having heart-shaped shells, but clawed limbs, and a vacuity in the centre of the plastron, these forming an extinct family (*Acichelyidæ*) from which the modern turtles have probably originated.

LEATHERY TURTLES

Family *DERMOCHELYIDÆ*

The remarkable leathery turtle or luth (*Dermochelys coriacea*), which is the solitary survivor of a series of extinct forms, is one of those animals whose serial position is a matter of dispute among naturalists; some of whom regard it as so different from all other Chelonians, that it ought to represent a suborder by itself, while others believe it to be merely a highly-specialized form allied to the true turtles. From the evidence afforded by extinct species, the latter view, to our



LEATHERY TURTLE.
(One-twentieth natural size.)

thinking, appears the more likely to be the true one. The essential peculiarity of the leathery turtle is to be found in the nature of its carapace, which is a mosaic-like structure composed of a number of irregular discs of bone closely joined, and entirely free from the backbone and ribs. In certain extinct forms the carapace, on the other hand, is represented merely by a row of marginal bones, from which it is inferred that these reptiles have been derived from true turtles by

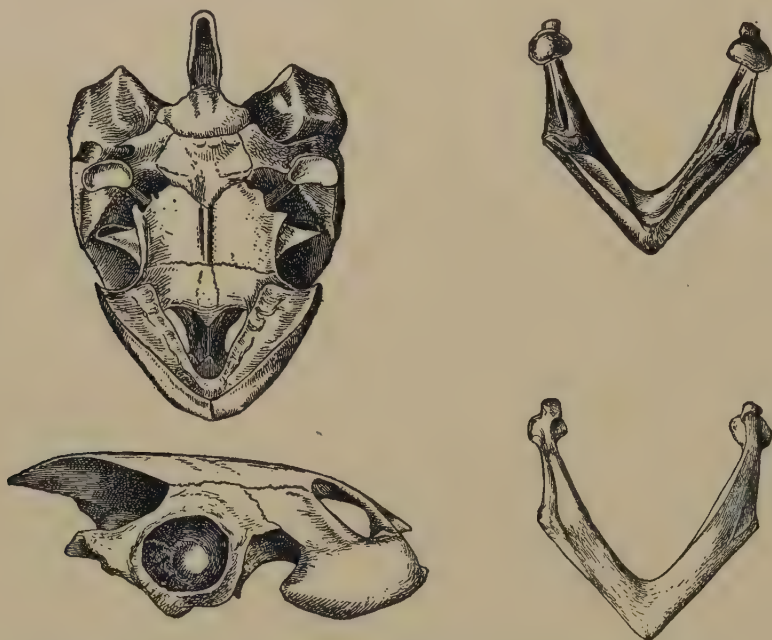
a gradual disintegration and breaking up of the carapace. In the living genus the carapace is completely bony, and marked by seven prominent longitudinal keels; but the plastron is much less fully ossified, and carries five similar keels, the unpaired entoplastral bone being wanting. The head, which is covered with small shields, is remarkable for its relatively-large size and globose form, the beak having two triangular cusps situated between three deep notches. The jaws differ from those of the true turtles in being sharp edged from end to end, without any expanded bony palate; and there is also an important difference in the structure of the skull itself, which may, however, be apparently the result of specialization. As in the true turtles, the limbs are converted into flattened paddles, which are, however, completely destitute of claws, the front pair being much elongated, narrow, and pointed, while the hinder ones are short and truncated. The humerus, or bone of the upper arm, has the same general form as in the true turtles, and is thus very unlike the corresponding bone of other members of the order. The process marked *h* in the accompanying figure is more developed than in the turtles, and the foramen *e* at the lower end is unique in the order. Largest of living turtles, the leathery turtle exceeds six feet in length; and while in the young the front flippers are equal in length to the shell, in the adult they become shorter. The general color is dark brown, which may be either uniform, or relieved with yellow spots; the longitudinal tuberculated keels on the shell, as well as the margins of the limbs, being invariably yellow in the young.

This turtle is generally distributed throughout the tropical portions of the Atlantic, Indian, and Pacific Oceans, from whence it occasionally wanders to the coasts of cooler regions. Yearly becoming scarcer, it is, however, one of those species which stand a fair chance of extermination at no very distant date. Although but little is known as to the mode of life of this turtle, it appears that its food is chiefly of an animal nature, comprising fish, crustaceans, and mollusks. In the breeding season it appears in numbers on the Tortugas islands, off the coast of Florida, and sometimes in still greater abundance on the sandy shores of Brazil. Arriving somewhat later than the true turtles, it deposits its eggs in a similar manner, laying as many as three hundred and fifty in two batches; while at times, when three or more females have a nest in common, upward of a thousand eggs may be found in a single spot. When hatched, the young turtles immediately seek the water, where, however, they have almost as many foes as on land; so that it is probable only a very small percentage arrive at maturity. The strength and weight of a full-grown individual are very great; one captured some years ago, on the coast of Tenasserim, requiring the combined efforts of ten or twelve men to drag it on to the beach. The flesh has an unpleasant flavor, and is not, therefore, generally eaten.



FRONT VIEW OF LEFT HUMERUS OF AN EXTINCT LEATHERY TURTLE.

Gigantic as is the existing leathery turtle, it was considerably exceeded by some of its extinct allies. Among these, the huge *Eosphargis* from the London Clay, with a skull of nearly a foot in length, apparently had a carapace consisting only of one median row of broad-keeled bony plates, and a border of marginal bones; while in *Psephophorus* from the higher Eocene and Miocene strata of the Continent, both upper and lower shells were formed of mosaic-like bones, which, it is thought, were overlain by horny shields. In the earlier *Protostega* and *Protosphargis* from the Cretaceous rocks of North America and Europe, the upper shell appears to have been represented merely by a row of marginal bones, while the lower one was very stoutly ossified; some of these early forms probably attained a length of from ten to twelve feet.



LOWER AND SIDE VIEWS OF SKULL, AND UPPER AND LOWER ASPECTS OF LOWER JAW OF GREAVED TORTOISE.

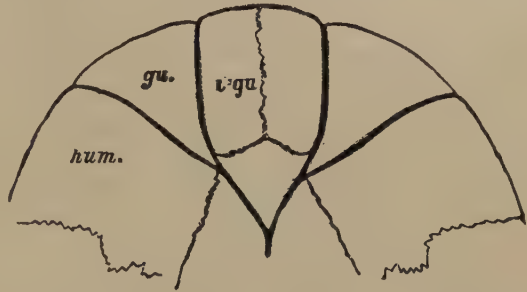
(From Gray, *Proc. Zool. Soc.*, 1870.)

THE SIDE-NECKED TORTOISES

Families *CHELYIDÆ* and *PELOMEDUSIDÆ*

In place of withdrawing the head into the shell by means of an S-like flexure of the neck in a vertical plane, as in all the groups hitherto described, the remainder of the living tortoises with complete shells bend the neck sideways in a horizontal plane (as shown in the illustration on page 2450), and thus bring the head within the margins of the shell. Accordingly, the group is collectively

spoken of as the side-necked tortoises, or Pleurodira. This characteristic is alone amply sufficient to separate the group from the foregoing assemblage of S-necked or Cryptodiran tortoises, but since there are also certain features by which the skulls and shells of the two groups can be identified, it is important that these should be noticed. As regards the skull, this is distinguished in the first place by the tympanic ring surrounding the aperture of the ear being complete, as may be seen by comparing the preceding figure with the one on p. 2404, and also by the circumstance that the lower jaw articulates by means of a knob-like condyle



FRONT PORTION OF THE PLASTRON OF A SIDE-NECKED TORTOISE WITH THE HORNY SHIELDS REMOVED.

The thick lines indicate the boundaries of the shields.

with a corresponding cavity in the quadrate bone, whereas in the preceding group the positions of the condyle and cup are reversed. The shell, which is always fully developed and forms a solid box, presents the peculiarity that both the carapace and the hinder part of the plastron are immovably welded to the bones of the pelvis; its upper and lower moieties thus having a bond of union which is totally lacking among the S-necked tortoises. Further, the vertebræ of the neck are furnished with projecting lateral or transverse processes, which are absent from the latter group.



RIGHT HALF OF THE CARAPACE OF THE BLACK STERNOTHERPE WITH THE HORNY SHIELDS REMOVED.

In addition to these absolutely characteristic features, there are certain other points connected with the anatomy of the side-necked tortoises which demand a brief notice. With the exception of one species, which lacks horny shields on the shell, the whole of these tortoises are characterized by the presence of an intergular (*i.gu*) shield between the two gulars (*gu*) on the front of the plastron; such intergular shield being, as we have seen, but very rarely present in the S-necked group. Very generally among the present assemblage one or more of the pairs of costal bones of the carapace may meet in the middle line, owing to the absence of some of the median unpaired series of bones; in certain cases the whole of the costals thus meeting, owing to the absence of all the neural bones.

Whereas, in one family of the group the plastron contains the same nine bones as in the side-necked tortoises, in a second family there are eleven bony elements in this part of the shell, owing to the presence of

an additional (mesoplastral) pair between the normal hyoplastral and hypoplastral bones.

The side-necked tortoises, of which the great majority may be included in the two families mentioned above, are all of fresh-water habits, and at the present day are exclusively restricted to the Southern Hemisphere, while they are the only members of the order found in Australia and New Guinea. During the earlier portion of the Tertiary period they extended, however, into the Northern Hemisphere, and in the preceding Secondary period were abundantly represented in Europe. These facts show that the group is a very ancient one; and by the presence of the additional mesoplastral elements in the lower half of the shell of some of its representatives it is allied to a third and totally extinct group, which disappeared before the close of the Secondary period.

**Matamata
Tortoise**

The extraordinary reptile depicted in the following illustration, and known as the matamata (*Chelys fimbriata*), is the typical representative of the first of the existing families of the group — *Chelyidae*. The various genera included therein are collectively characterized by having the normal nine bones in the plastron, by the neck being incapable of complete retraction within the margins of the shell, and the absence of a bony temporal arch to the skull. Eight genera are included in the family, the range of which is restricted to South America, Australia, and New Guinea.

The matamata, which is an American species inhabiting Guiana and Northern Brazil, and is the sole representative of its genus, is easily recognized by its broad and elongated neck, of which the sides are fringed with peculiar fimbriated projections, and the depressed and triangular head terminating in a proboscis-like nose, and furnished with very small eyes. Not less characteristic is the equally depressed and much corrugated shell, in which the carapace bears three longitudinal ridges, subdivided into nodose protuberances by cross valleys; the horny shields of the same being extremely rugose, and marked with deep radiating striæ. The vertebral shields are broader than long, and the hinder marginals are more or less strongly serrated, while there is a distinct nuchal shield on the front edge of the carapace. On the removal of the horny shields from the carapace, it is seen that only the last pair of costal bones meet in the middle line, owing to the presence of but seven neural bones. The plastron is narrow and deeply notched behind, the tail is very short, and the toes are fully webbed. In addition to the rows of fimbriated appendages on each side of the neck, there is a similar outgrowth of skin on the chin and larger pair of appendages above the ears. In color the adult is uniform brown, but the young are prettily marked with bands of brown and yellow on the chin and neck, while the shell is ornamented with black and yellow spots. The species is of comparatively-large size, the shell attaining a length of fifteen inches.

Unfortunately, but little is known as to the mode of life of this strange tortoise. When in its native element, the warty appendages on the neck float in the water like some vegetable growth, while the rugged and bossed shell strongly resembles a stone; and it is thus probable that the whole appearance of the creature is advantageous either in deluding its enemies or in attracting to it the animals on which it feeds — the latter being the more likely hypothesis. Although it appears that the

matamata will occasionally eat vegetable substances, its chief food consists of fish, frogs, and tadpoles, some of which may probably be attracted within reach by mistaking the appendages on the neck for plants or animals on which they feed. The matamata is, however, stated to capture some of its prey by swimming swiftly among water plants, diving immediately when a fish or frog is seized in its beak. In captivity this tortoise is sluggish, frequently dying after a few weeks through refusal to feed.

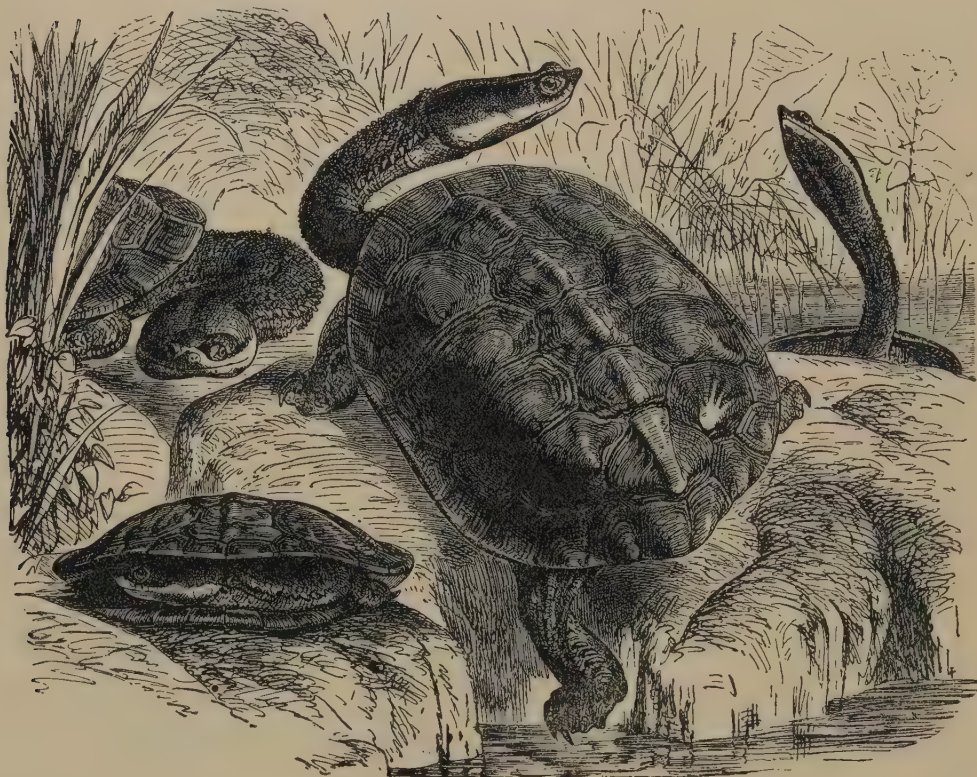


MATAMATA TORTOISE.
(One-fifth natural size.)

Snake-Necked Tortoises The snake-necked tortoises, of which there are two South-American species (*Hydromedusa maximiliani* and *tectifera*), agree with the matamata in their long necks and weak jaws, but differ in their smooth shell, the absence of a proboscis to the nose, and the presence of only four claws on each foot — the matamata having five claws on the fore-feet and four on the hinder pair. The flattened shell in the young state has an interrupted median ridge, and presents the unique peculiarity that the broad nuchal shield of the carapace is placed behind the first pair of marginals (which consequently meet in the middle line), and thus simulates a sixth vertebral shield. The figured species (*H. tectifera*), which ranges from Southern Brazil to Buenos Ayres, has a shell measur-

ing eight inches in length, and its feet largely webbed. In color, the carapace is dark brown and the plastron yellowish, with brown spots in the young; the head and neck being olive, with a curved white streak on each side of the throat, and a broader white band, edged with black, running along the sides of head and neck.

Nocturnal and carnivorous in their habits, the snake-necked tortoises appear to agree in their general mode of life with the majority of fresh-water species. During the daytime they are generally to be found lying asleep on some dry spot near the



SNAKE-NECKED TORTOISE.
(One-third natural size.)

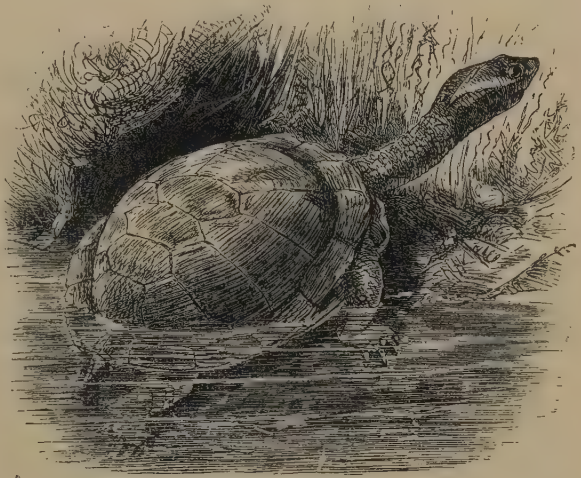
water, with the neck bent on one side, and the head, like the limbs and tail, retracted within the margins of the carapace. When disturbed, the head and neck are, however, shot out with marvelous rapidity, reminding the observer of the sudden dart of a snake.

In Australia and New Guinea the place of the preceding group is taken by another genus of long-necked tortoises, technically known as *Chelodina*, the members of which may be recognized by the presence of a normally placed nuchal shield on the carapace, coupled with the circumstance that the intergular shield of the plastron, instead of being placed between the gulars, as in the figure on p. 2447, is situated behind the

Australian
Long-
Necked
Tortoises

latter, which consequently meet in the middle line. The vertebral horny shields are longer than broad, and the whole of the shields remarkable for their extreme thinness. On removing the latter from the carapace, it will be found that, owing to the absence of neural bones, all the pairs of costal bones meet in the middle line,—a peculiarity shared with one American, and two other Australian genera of the family. There are four species of these long-necked tortoises, three of which are found in Australia, while the fourth is Papuan.

In addition to the foregoing, there are four other genera belonging to the family under consideration, collectively distinguished by their shorter necks, the length of which is inferior to that of the back. Of these the American *Rhinemys*, *Hydraspis*, and *Platemys* are characterized by the narrow anterior extremity of the lower jaw, and by the first vertebral shield of the carapace being wider than either of the others. The second of these genera, of which a member is represented in the accompanying figure, is by far the most numerous in species, and is noteworthy on account of being represented by a fossil species in the Eocene deposits of India. The third genus differs from the other two in the absence of neural bones to the carapace. On the other hand, the two



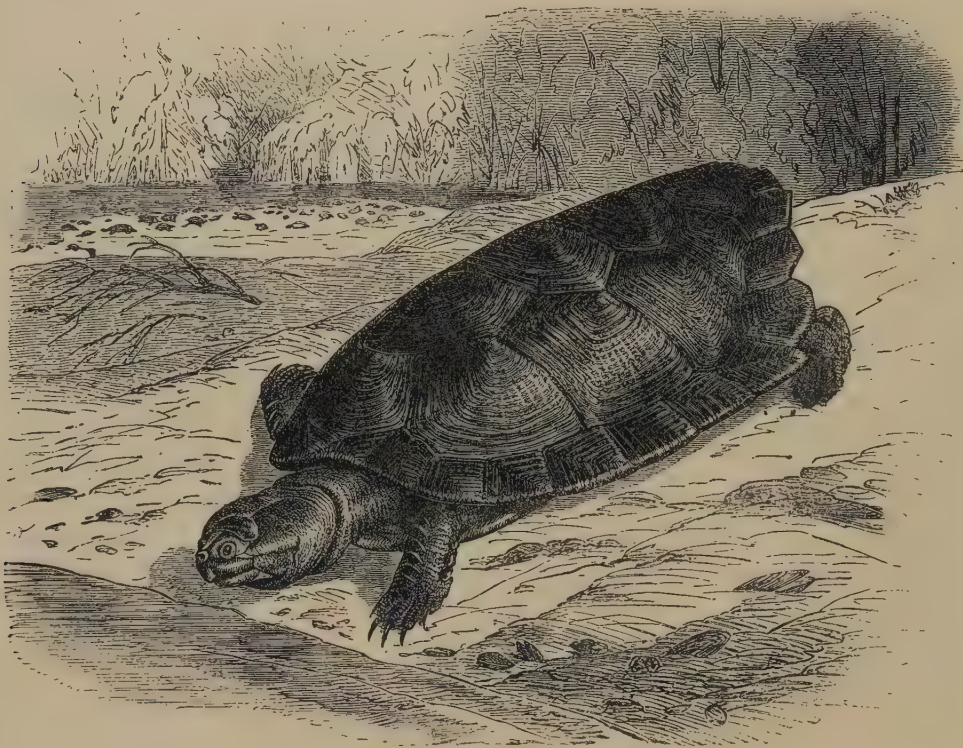
AN AMERICAN SIDE-NECKED TORTOISE (*Hydraspis*).

Australian genera,—*Emydura* and *Elseya*,—both of which present the feature last mentioned, are distinguished by the broad anterior extremity of the lower jaw, and by the first vertebral shield of the carapace not exceeding the others in size.

The tortoises which may be conveniently designated by a translation of their scientific title (*Podocnemis*)—so named on account of the presence of a pair of large shields on the outer side of the hind-foot of the typical species—bring us to the second family of the group under consideration. This family (*Pelomedusidæ*), which contains three genera, and is now confined to Africa, Madagascar, and South America, is broadly distinguished from the last by having eleven elements in the plastron, owing to the presence of a pair of mesoplastral bones; while the neck is completely retractile within the margins of the shell. The skull differs from that of the preceding family in having a bony temporal arch, as shown in the figure on p. 2446; while it lacks the distinct nasal bones generally found in the former.

The largest and best-known representative of the whole family is the giant Amazonian tortoise (*Podocnemis expansa*), which considerably exceeds in size all other members of the entire group, having a shell which may measure as much as

thirty inches in length. It belongs to a genus including seven existing species, of which six are South American, while the seventh is an inhabitant of Madagascar. This extremely anomalous distribution is to some extent explained by the occurrence of a fossil representative of the genus in the Eocene strata of India, which probably indicates that these tortoises were at one time widely spread. As a genus, these tortoises are characterized by the skull having a roof over its temporal region, coupled with the presence of five claws on the fore-feet, and four on the hinder pair, and likewise by the circumstance that the mesoplastral bones are small and confined to the edges of the plastron, so that they are widely



GIANT AMAZONIAN TORTOISE.
(One-sixth natural size.)

separated from one another in the middle line. The toes are broadly webbed, and the tail is remarkable for its extreme shortness.

The figured species, which inhabits tropical South America to the eastward of the Andes, and is extremely abundant in the upper part of the Amazonian system, has the shell expanded posteriorly, and much depressed in the adult, although at an earlier stage it has a roof-like form. The chin is furnished with two small wart-like appendages, and the hind-foot characterized by the presence of two very large shields on its outer side. In color, the upper shell is brown or olive, with darker markings, while the plastron is yellowish, spotted with brown; the young

being olive above and yellow beneath, with some yellow spots on the head. All the other members of the genus are of greatly inferior dimensions; a second Amazonian species (*P. sextuberculata*), having a shell of scarcely more than a foot in length, and being distinguished from its larger relative by the presence of only a single wattle on the chin.

The best account of the habits of these tortoises is the one given by Humboldt, who speaks of the large species by its native name of *arran*. On the Orinoco, according to this account, the period of egg laying coincides with that of the lowest level of the waters of the river, or from the end of January till the latter part of March. During January the tortoises collect in troops, which soon leave the water to bask on the warm banks of sand exposed by the lowering of the river. Throughout February they may be found on such banks during the greater part of the day; but early in March the several troops collect in larger bodies, and then make their way to the comparatively-few islands where the eggs are habitually deposited. At this time, shortly before the egg laying commences, thousands of the tortoises may be seen arranged in long strings around the shores of the islands in question, stretching out their necks, and holding their necks above water, in order to see whether there is anything to prevent their landing in safety. As the creatures are exceedingly timid, and especially averse to the presence of human beings or boats, the Indians, to whom the harvest of tortoise eggs is of the utmost importance, take every precaution to prevent them being disturbed, posting sentinels at intervals along the banks, and warning all passing boats to keep in the middle of the river. When the tortoises have landed, the laying of the eggs takes place at night, and begins soon after sunset; the females digging holes of some three feet in diameter and two feet in depth, by the aid of their powerful hind-limbs. So great is the contention for space, that one tortoise will frequently make use of a pit dug by a neighbor, and in which one set of eggs has already been deposited, although not yet covered over with sand, two layers of eggs thus occupying one area. The crowding and jostling of the reptiles necessarily leads to an immense number of eggs being broken, which is estimated at a fifth of the whole; the contents of the fractured shells in many places cementing the loose sand into a coherent mass. The number of tortoises on the shore during the night being so large, many of them are unable to complete the work of egg laying before dawn, and these belated individuals become quite insensible to danger, continuing there even in the presence of the Indians, who repair to the spot at an early hour.

The great assemblage of these Chelonians takes place on one particular island in the Orinoco, hence known as the Boca de la Tortuga, and according to native accounts, no other spot is to be met with on the river from its mouth to its junction with the Apure, where eggs can be found in abundance. On the island in question, the number of eggs deposited is enormous, a large stretch of smooth sandy beach being underlain with an almost continuous layer. To determine the position and extent of the deposit, a long pole is thrust down at intervals into the sand; the sudden want of resistance to its descent proclaiming when the loose layer containing the eggs has been reached. According to measurements taken by Humboldt, the stratum extended to a distance of one hundred and twenty feet from the water, and

averaged three feet in depth. The whole is regularly parceled out among the Indians, who proceed to work the layer with the regularity of miners. The earth having been removed, the eggs are carried in small baskets to the neighboring encampment, where they are thrown into long wooden troughs of water. Here they are broken and stirred up with shovels, and the mass then left in the sun till all the oily matter has collected at the surface, whence it is continually ladled off, and taken off to be boiled over a quick fire. The result of this process is a limpid, inodorous, and scarcely yellow substance, known as "turtle butter," which can be used for much the same purposes as olive oil. In spite of the enormous quantity of eggs thus taken, numbers are hatched, and Humboldt saw the whole bank of the Orinoco swarming with small tortoises of an inch in diameter, that escaped only with difficulty from the pursuit of the Indian children. All these tortoises are vegetable feeders, and the females greatly exceed the males in size. On the Upper Amazon the large species, according to Bates, is captured either by means of nets or by shooting with arrows. On such occasions, after the net is set in a semicircular form at one extremity of a pool, the rest of the party spread themselves around the swamp at the opposite end, and begin to beat with poles in order to drive the tortoises toward the middle. This process on the occasion referred to "was continued for an hour or more, the beaters gradually drawing nearer to each other, and driving the hosts of animals before them; the number of little snouts constantly popping above the surface of the water showing that all was going on well. When they neared the net, the men moved more quickly, shouting and beating with great vigor. The ends of the net were then seized by several strong hands and dragged suddenly forward, bringing them at the same time together, so as to inclose all the booty in a circle. Every man now leaped into the inclosure, the boats were brought up, and the turtles easily captured by the hand and tossed into them." Altogether, about eighty individuals were captured in the course of twenty minutes or so. In shooting tortoises, the arrow employed has a strong lancet-shaped steel point, fitted to a peg which enters the tip of the shaft. To the latter the peg is secured by a hank of twine some thirty or forty yards in length, and neatly wound round the body of the arrow. When a tortoise is struck, the peg drops out from the shaft, and is carried down by the diving animal, leaving the latter floating on the surface. Thereupon the sportsman paddles up to the arrow, and proceeds to "play" his victim until it can be drawn near to the surface, when it is struck with a second arrow, after which, by the aid of the two cords, it can be safely drawn ashore. In many villages on the Amazon every house has a pond, in which a number of these tortoises are kept for food.

The other two genera of the family — *Pelomedusa* and *Sternotherus* — differ from the first by the absence of a bony roof to the temporal region of the skull, and likewise by the presence of five claws in both the front- and hind-feet. Whereas, however, the former has the mesoplastral elements of the plastron small and similar to those of the greaved tortoises, in the latter they are as well developed as the other elements of the plastron, meeting in the middle line. *Pelomedusa* is represented by a single species common to Africa and Madagascar, but of the six species of *Sternotherus*, five are exclusively African, while the sixth

inhabits both Eastern Africa and Madagascar. The right half of the upper shell of one of the species is represented on p. 2447.

Fly River Turtle A remarkable Chelonian (*Carettochelys insculpta*) from the Fly river, New Guinea, differs from all other members of the group, in the absence of horny shields on the shell and the conversion of the limbs into paddles, each of which carries but two claws. The neck is not retractile. In the carapace there are six very small neural bones, which are not in contact with one another, thus allowing each pair of costals to meet in the middle line; and the plastron has only the usual nine bones. A wavy sculpture ornaments the whole of the external surface of the shell, which attains a length of about eighteen inches. The head is large, and the tail relatively short. The species, which represents a separate family (*Carettochelyidae*), is still very imperfectly known, and it has been suggested that it does not belong to this group at all. It is not improbable that a Chelonian (*Hemichelys*) from the Eocene rocks of India indicates a second member of the same family, as its shell was similarly devoid of horny shields.

Australian Horned Tortoises Probably the most aberrant members of the whole order were certain gigantic tortoises (*Miolania*) from the superficial deposits of Australia, characterized by the presence of several pairs of horn-like protuberances on the skull, and also

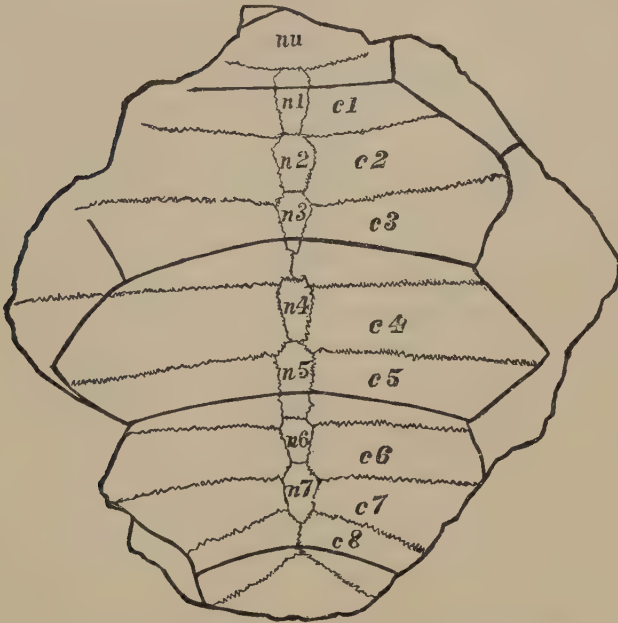
by the investment of the tail in a bony sheath, recalling that of the armadillos. Unfortunately, the shell of these strange reptiles is known only by fragments; but, from the conformation of the bones of the feet, we are enabled to say that they were terrestrial, while the structure of the palate indicates that they were herbivorous. They clearly constitute a fourth family (*Miolaniidae*) of side-necked tortoises.



FRONT VIEW OF SKULL OF HORNED TORTOISE.

Extinct European Genera The Secondary rocks of Europe contain the remains of a number of extinct tortoises which may be referred to a fifth family (*Plesiochelyidae*) of the group. While agreeing with the existing *Chelyidae* in having but nine bones in the plastron, these extinct forms differ by the much greater thickness of their shells, and also by the circumstance that only one of the lower bones of the pelvis is welded to the upper surface of the plastron, whereas in the existing families both are thus united. Abundant in both the Oölitic and Wealden rocks, the majority of these tortoises are referred to the genus *Plesiochelys*, although some, as the one of which the carapace is represented in the figure on the next page, are separated as *Hylæchelys*, being distinguished by the enormous width of the vertebral shields, in which the breadth may be three times the length. Nothing approaching this conformation is to be met with among living representatives of the order.

Generalized Chelonians Certain extinct tortoises, such as *Pleurosternum* from the Purbeck Oölite of Swanage, and *Baëna* of the Eocene rocks of the United States, indicate the existence of an extremely generalized group of the order *Amphichelydia*, presenting many characteristics common to the existing



IMPERFECT CARAPACE OF WIDE-SHIELDED WEALDEN
TORTOISE.

S-necked and Side-necked groups, and which may have been the ancestral stock of both the latter. All have eleven bones in the plastron, owing to the presence of mesoplastrals, and an intergular shield, but the pelvis may or may not be connected with the plastron. In the first of the genera named, the mesoplastral bones extend right across the shell to meet in the middle line, and one of the bones of the pelvis articulates to a smooth oval facet on the plastron. On the other hand, in the second genus, the mesoplastral bones are incomplete, as in the existing greaved tortoises, and there is no union between the

pelvis and the plastron. Since it is probable that the plastron of the Chelonians has originated from a system of abdominal ribs similar to those of the tuateras (Chapter VI.), it is interesting to notice that these generalized tortoises had a larger number of plastral elements than are to be found in the majority of the existing representatives of the order.

THE SOFT TORTOISES

Family *TRIONYCHIDÆ*

The last group of the order comprises the soft river tortoises, now confined to the warmer regions of Asia, Africa, and North America, but which, during the middle portion of the Tertiary period, appear to have been extremely abundant in the rivers of England and other parts of Europe. The whole of these tortoises are included in a single family which forms a group of equivalent value to the S-necked and Side-necked sections; and it is not a little remarkable that while in the greater part of their organization they approximate to the former group, in certain features connected with the skull they come nearer to the latter. The most striking peculiarity of the soft tortoises is to be found in the nature of their shells, which are covered with a raised sculpture of variable form, and are quite devoid of horny shields. The lower shell, or plastron, is always very imperfectly ossified, and completely separate from the carapace, while the carapace never has a complete series

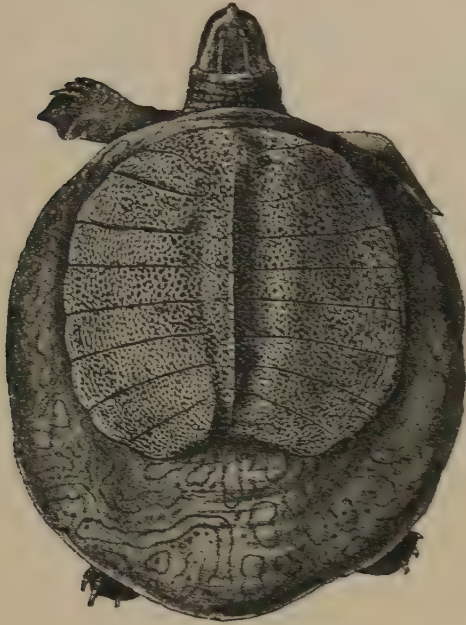


SOFT RIVER TORTOISES.

of marginal bones, and passes at its borders into a soft expansion of skin, from which the name of the group is derived. If marginal bones occur at all, they are confined to the hinder border of the shell, and are unconnected with the ribs; having, in fact, nothing in common with the bones so named in other tortoises, and being doubtless of independent origin. In being unconnected with the plastron, the pelvis resembles that of the S-necked group, and the head is retracted by a similar S-like flexure of the neck in a vertical plane. In regard to the mode of articulation of the lower jaw with the skull, and likewise in the presence of a notch in the hinder border of its tympanic ring, the soft tortoises again resemble the group last mentioned; although in the general form of the skull and the conformation of the palate they come nearer to the Side-necked group. A distinctive peculiarity of the skeleton is to be found in the presence of at least four joints in the fourth toe of each foot. Externally, the soft tortoises are characterized by their long necks, which, together with the head, can be completely withdrawn into the shell, and also by the proboscis-like snout, and the thick fleshy lips concealing the jaws. The ear is completely concealed; and each foot, as indicated by the scientific name of the group, has but three claws, which are borne by the three inner toes. As a rule, the color of the skin is greenish olive, with yellow or orange spots, passing into streaks on the under surface of the head; while some species have a few much larger eye-like spots on the back of the shell.

Although the whole of the soft tortoises are included in a single family, they are arranged in six distinct genera, three of which are nearly allied to one another, as are likewise the remaining three among themselves. The first and largest genus, *Trionyx*, contains fifteen living species, with a distribution coextensive with that of the family. These are characterized by the absence of a fold of skin on the hinder part of the under shell, beneath which the leg may be concealed, by the sculpture on the shell being generally in the form of wavy raised lines, and by the hyoplastral and hypoplastral bones of the lower shell remaining distinct from one another. In the skull, as shown in the figure on p. 2446, the sockets of the eyes are placed relatively far back, and widely separated from the aperture of the nose. Among the better-known species we may mention the Gangetic soft tortoise (*T. gangeticus*), now confined to the river system from which it takes its name, but formerly found, as shown by fossil specimens, in the Narbada, the length of the shell and fleshy disc reaching as much as two feet. Like all the Old-World representatives of the genus, this species has eight pairs of costal bones in the carapace; while it belongs to a subgroup characterized by having two neural bones between the first pair of costals, and by the absence of a pronounced ridge in the middle of the upper surface of the extremity of the lower jaw. The soft tortoise of the Nile (*T. triunguis*), ranging over Africa and Syria, and attaining still larger dimensions, belongs to a second subgroup, distinguished by having only a single neural bone between the first costals; while Phayre's soft tortoise (*T. phayrei*) of Burma may be taken to represent a third section differing from the last by the presence of a median ridge in the front of the lower jaw. On the other hand, all the American soft tortoises, of which *T. ferox* is a well-known example, differ by having only seven pairs of costal bones. Numerous representa-

tives of the genus occur in the Miocene and Eocene strata of Europe, as well as in the Tertiary rocks of India and the United States. Two other members of



CANTOR'S SOFT TORTOISE.

the first subfamily, confined to Asia, represent as many genera. Of these Cantor's soft tortoise (*Pelochelys cantori*) from India, Burma, and Malaya has the sockets of the eyes placed more anteriorly than in the type genus. This forward position of the eye sockets is still more marked in the much elongated skull of the great Indian chitra (*Chitra indica*), where they are placed close up to the nose.

The three remaining genera of the family are characterized by the sculpture of the shell generally taking the form of small pustules, and thus resembling shagreen; the hyoplastral and hypoplastral bones of the lower shell are united, and there is a flap of skin on each side of the under surface, beneath which the hind-limbs can be concealed. All the forms are

confined to the Old World; and while one of the three genera is Indian, the other two are African. The Indian genus *Emyda* is readily characterized by the presence of a complete series of neural bones in the carapace, coupled with a semicircle of marginal bones at its hinder extremity. In neither of the three living species does the length of the shell and its soft disc exceed ten inches, but much larger fossil forms are found in the Pliocene rocks of India. Both the African genera lack marginal bones, but whereas in one (*Cycloderma*) there is a full series of neural bones to the carapace, in the other (*Cyclanorbis*) these form an incomplete and interrupted series.

Habits All the soft tortoises are thoroughly aquatic, most of them but rarely leaving the water except for the purpose of laying their eggs. and in consequence of these habits very little is known as to their mode of life. Although confined as a rule to rivers, a few of the species frequent estuaries, and Cantor's soft tortoise has been found some distance out at sea. Occasionally, again, specimens of the Indian granulated soft tortoises have been met with wandering on land far from the neighborhood of water. Fiercer and more spiteful than any other members of the Chelonian order, these tortoises, owing to a peculiarity in the structure and mode of articulation of some of the vertebræ of the neck, have the power of darting out the head with inconceivable rapidity, the great Indian chitra being *facile princeps* in this respect. Owing to this habit the larger species are dangerous creatures to approach incautiously, as their bite is very

severe, and the natives are not unfrequently bitten by them in India and Burma while bathing. All the members of the typical genus, together with Cantor's soft tortoise and the chitra, are known to be carnivorous, and it is commonly believed that the same is the case with the other members of the group. According, however, to Dr. J. Anderson, this is incorrect with regard to the granulated soft tortoises of India, which he expressly states to be exclusively vegetable and grain feeders. The larger species probably feed both on fish and other aquatic animals, and on the flesh of such carcasses as may be floating in the rivers they inhabit. In correlation with their asserted herbivorous habits, the small granulated species do not snap and bite after the manner of their larger cousins. On shore, according to the observer last mentioned, when left to themselves, these species will slowly and cautiously extend their necks, and when approached, instead of attempting to escape, withdraw rapidly into their shells, of which the upper and lower anterior margins then meet. It is stated that all the species are chiefly nocturnal, remaining during the daytime partially or completely buried in the mud at the bottom of the water, and not beginning to swim until sundown. Such species as inhabit marshes or swamps, liable to be dried up during the hot season, bury themselves in the mud, at no great depth below the surface, during the period of drought. As these tortoises are known to remain frequently for a period of from two to ten hours, and occasionally as long as fifteen hours, beneath the water, without coming to the surface to breathe, it is obvious that they must have some special means of oxygenating their blood. It is probable, indeed, that certain filamentous appendages of the mucous membrane of the throat found in these tortoises subserve the office of gills, and thus enable the blood to be renovated by means of the atmospheric air dissolved in the water they inhabit. With regard to their breeding habits, it appears that the females of the granular shelled species scrape a shallow hole in the mud, in which the eggs are laid and then carefully covered up, the eggs themselves being round, and about an inch in diameter.

THE PLESIOSAURS OR LONG-NECKED MARINE LIZARDS

Order *SAUROPTERYGIA*

Strikingly different in appearance as are the skeletons of the members of the two groups, it appears that, on the whole, the nearest allies of the tortoises and turtles are those extinct reptiles known as plesiosaurs, or long-necked marine lizards, whose range in time embraced the whole of the great Secondary period, during which were deposited the vast series of strata extending from the Chalk downward through the Oölites to the Lias and Trias. These reptiles agree with the tortoises in that all or nearly all of the ribs of the back are articulated to the vertebræ by single heads, and in the absence of hook-like (uncinate) processes to the ribs, as well as in the want of a breastbone or sternum. In the skull the quadrate bone is immovably fixed, and the palate more or less completely closed.

Both groups have the lower bones of the pelvis expanded into large flat plates, and there is also a similarity in the structure of the bones of the limbs.

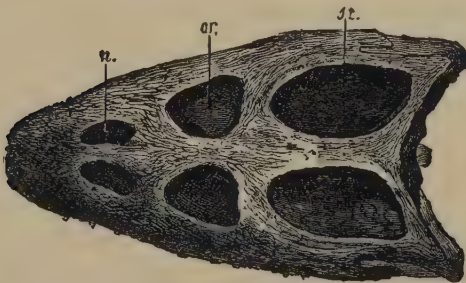
Whereas, however, the tortoises have the upper surface of the body covered with a shell, and the lower aspect of the same protected by a plastron, the plesiosaurs were entirely naked, the plastron being represented by a numerous



RESTORED SKELETON OF A PLESIOSAUR.
(Greatly reduced.)

series of abdominal ribs, each composed of three pieces, forming a forwardly-directed angle. The skull differs from that of the crocodiles in having but one (lower) temporal arch; and the jaws are furnished with a number of pointed and grooved teeth, implanted in distinct sockets; one of such teeth being figured on p. 2361. The neck was generally much elongated, and its vertebræ differ from those of crocodiles in that their ribs which may have either single or double

heads, are articulated only to the body of each vertebra (as shown in the accompanying figure); those of crocodiles always having two heads, of which the lower is articulated to the body, and the upper to the arch of the vertebra. Throughout the backbone the bodies of the vertebræ have either nearly flat or slightly-cupped articular surfaces; and in the region of the back each pair of ribs is articulated to a process arising from the arch of each vertebra, instead of from a facet placed at the junction of two vertebræ, as in the tortoises. Although there are other interesting fea-



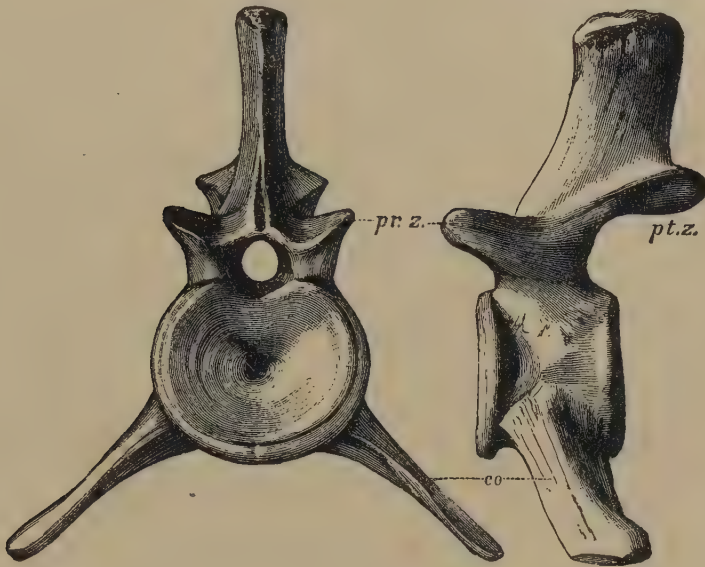
UPPER SURFACE OF THE SKULL OF THE
SIMOSAUR OR TRIASSIC PLESIOSAUR.
(One-fourth natural size.)

n. nostrils; *or.* eye socket; *st.* temporal fossæ.
(From Gaudry.)

tures in these reptiles, those mentioned distinguish them from crocodiles and dinosaurs on the one hand, and tortoises and turtles on the other.

With regard to the various groups into which the order is divided, it may be mentioned that in the typical forms, constituting the family *Plesiosauridæ*, the limbs, as shown in the above figure, are converted into flattened paddles, with

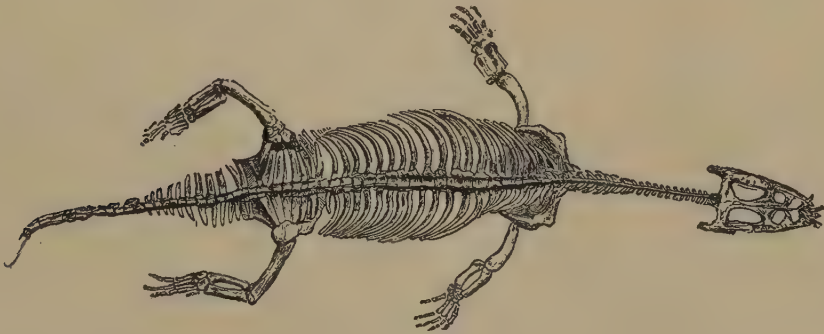
a shortening of the bones of the upper segments, and an increase in the number of bones corresponding with those of the toes of ordinary reptiles. In the true plesiosaurs (*Plesiosaurus*) of the Lias, the ribs of the neck were articulated to the



FRONT AND SIDE VIEWS OF A NECK VERTEBRA OF A PLESIOSAURIAN.

pr. z. and *pt. z.* anterior and posterior articular surfaces of the arch; *co.* rib.

vertebræ by two heads; whereas in the later cimoliosaurs (*Cimoliosaurus*) of the Oölites and Chalk, such ribs, as shown in the figure of a neck vertebra, were single headed. Some of these creatures were of huge size, attaining a length of between thirty and forty feet; certain of the species from the Cretaceous strata



UPPER ASPECT OF THE SKELETON OF THE LARIOSAUR, A SMALL PLESIOSAURIAN.

having a neck much exceeding the body and tail in length, and containing as many as forty vertebræ. Marine and carnivorous in their habits, these formidable creatures probably lurked in shoal waters from whence they darted their long necks

to seize passing fishes in their jaws. In the groups mentioned the head was comparatively small, but in the huge pliosaurs (*Pliosaurus*) of the upper Oölitic strata the skull was of enormous size, attaining in some instances a length of six feet, and the neck proportionately short and thick. Their teeth had more or less triangular crowns, and in some cases, inclusive of the root, measured quite a foot in length.

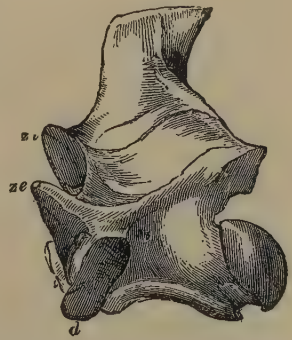
As in the case with all the higher aquatic Vertebrates, there is evidence to show that the plesiosaurs were originally derived from land animals; the representatives of the group found in the earlier (Triassic) Secondary rocks having limbs departing much less widely from the ordinary type, and bearing claws at the extremities of their digits. In the small lariosaur, which measured about a yard in length, the limbs appear to have been somewhat intermediate in structure between the clawless paddles of the true plesiosaurs and those of more ordinary reptiles; and the creatures were probably amphibious in their habits, spending part of their time on land, and part in the water. In the allied nothosaurs and simosaurs the limbs were better adapted for walking, from which we may infer that their owners were still more terrestrial in their habits.

CHAPTER IV

SCALED REPTILES—LIZARDS AND CHAMÆLEONS—ORDER SQUAMATA; SUBORDERS LACERTILIA AND RHIPTOGLOSSA

ALTHOUGH in popular language the term lizard is applied to any four-legged reptile, exclusive of turtles and crocodiles, in scientific usage it is more convenient to restrict it to those members of the great group of scaled reptiles which do not come under the designation of either chamæleons or serpents, whether they are provided with legs, or whether they lack those useful appendages. Formerly, indeed, lizards and chamæleons were regarded as constituting an order by themselves quite apart from serpents, but the two groups are now known to be so intimately connected as to render any such division inadmissible; and they are accordingly here placed in a single order, known as scaled reptiles, or, technically, Squamata. Structurally, this ordinal group differs very widely indeed from any of those hitherto treated, and as it is essential to gain a correct idea of such structural differences, they may first be taken into consideration.

Taking their name from the coat of overlapping horny scales
Skull with which they are generally invested, the scaled reptiles are primarily distinguished from all the foregoing groups by the circumstance that the quadrate bone is more or less movably articulated to the skull, and has its lower end projecting freely therefrom, instead of being immovably wedged in among the other bones. To this primary point of distinction it may be added that the lower temporal arch of the skull is wanting, so that there is no bony bar connecting the lower end of the quadrate bone with the upper jaw, as there is in the crocodiles, the absence of this bar being well shown in the figure of a lizard's skeleton. Then, again, the palate, instead of being more or less completely roofed over by bone, is largely open, its bones taking the form of long bars. In some lizards, as in the one of which the skeleton is figured, the upper surface of the skull is covered by bone, so that the temporal fossæ are roofed over.



LEFT SIDE OF THE VERTEBRA
OF A SNAKE.

Another important feature of the order is to be found in the circumstance that the ribs in the region of the back are single headed, and are articulated to the backbone by means of a facet (*d*) situated on the body of each vertebra. This feature at once distinguishes the order from the crocodiles and dinosaurs, in which the ribs are two headed, and in the back articulate to a long



(2464)

ROUGH-TAILED AGAMA BASKING.

process arising from the arches of the vertebræ; from the tortoises, where the single-headed ribs articulate at the junction between the bodies of the two vertebræ; and from the plesiosaurs, in which the single-headed ribs of the back are articulated to processes or facets on the arches of the vertebræ. In most of the members of the order the body of each vertebra has a cup in front and a ball behind, by which it articulates with the adjacent segments of the column — an arrangement paralleled among modern crocodiles. In some lizards, and in all snakes, the vertebræ, as shown in the figure on p. 2363, have additional surfaces on their arches for mutual articulation, thus communicating additional flexibility, and at the same time strength to the backbone.

Other Characteristics Another important feature in which the order differs from all the preceding ones, is the absence of any system of true abdominal ribs, or of their equivalent, a plastron, on the inferior surface of the body. As regards the teeth, these differ from those of the orders hitherto considered in that, instead of being implanted in separate sockets, they are firmly soldered to the bones of the jaw. In some cases they are attached to the very summit of the jaw-bones, when the detention is said to be *acrodont*; while in others they are affixed to one of the side walls of the free edges of the jaws, the term *pleurodont* being then employed. Another divergence from both crocodiles and tortoises is to be found in the vent opening by a transverse aperture, whereas in the former group it is longitudinal, and in the latter either circular or longitudinal. Finally, in those forms in which the bones of the chest attain their fullest development, there is a breastbone or sternum, a pair of collar bones or clavicles, and a median T-shaped interclavicle.

Special Characteristics of Lizards The above being the leading characteristics of the entire order of scaled reptiles, it remains to consider how the lizards (*Lacertilia*) are to be distinguished from the other two suborders into which the existing members of the assemblage are divided. Externally, by far the greater number of lizards are four-limbed reptiles of a crocodile-like appearance, with the head, neck, body, and tail well distinguished from one another, and if we had these alone to deal with, there would be no sort of difficulty in distinguishing between a lizard and a snake. The matter is, however, somewhat complicated by the circumstance that certain lizards, like the familiar slowworm, lose all external traces of limbs, and assume an elongated snake-like form, with the head passing imperceptibly into the body without the intervention of a distinct neck, and without any external indication of where the body ends and the tail commences. Externally, such snake-like lizards are very difficult to distinguish from snakes, but on opening the mouths of the former it will be found that the tongue cannot be withdrawn into a sheath at its base, as is always the case with the latter. Further help in discriminating between the two is afforded by the circumstances that whereas snakes have neither eyelids nor external ear openings, both these are usually, although not invariably, present in the limbless lizards. As additional distinctive features of the present group, by means of which they can be distinguished both from snakes on the one hand and from chamæleons on the other, the following points may be noticed. In all lizards the two branches of the lower jaw are united at the chin by means of a bony suture; while in all the species furnished with limbs

collar bones are present; and when the limbs are absent, some traces of the bones forming what is known as the shoulder girdle persist. In form the tongue is flattened, and, as already said, cannot be withdrawn into a basal sheath, although such a sheath may be present. In most of the members of the suborder the upper surface of the body is clothed with the overlapping scales characteristic of the order in general, these scales being in some cases underlain by bony plates; but in most geckoes the upper scales are granular, although sometimes juxtaposed.

Numerically, lizards are by far the most abundant of all reptiles at the present day, the total number of species not falling far, if at all, short of one thousand seven hundred, which are arranged under twenty distinct families. In this abundance at the present day, coupled with the specialized features of the greater part of their organization, lizards may be regarded as occupying a very similar position in the reptilian class to that held by the perching birds in the preceding class. With the exception of the polar and subpolar zones, lizards are distributed over the whole globe, ranging in some districts from the level of the sea to the limits of eternal snow, and found

Numbers and
Distribu-
tion



SKELETON OF LIZARD.

alike in fruitful and barren districts, in the neighborhood of water, and in the most arid deserts. Whereas, however, in the colder regions they are poor in species and small in size, it is in the tropics and subtropical regions that they attain their maximum development, as regards numbers, bodily size, richness of coloration, and peculiarity of form.

As regards their distribution over the surface of the globe, lizards present a most remarkable difference from what obtains among Amphibians (frogs, newts, etc.), and, to a less degree, among tortoises. For instance, whereas Amphibians, and to some extent tortoises, have their distributional areas defined equatorially, such lines of division, in the case of the present group, must be drawn meridionally. Thus, in the case of Amphibians, one great distributional province includes Europe, Asia, and North America, and the second embraces the regions lying south of the Equator; whereas in the case of lizards one area marked by peculiar forms will include the Old World and Australia, and the other will comprise the whole of

America. As has already been noticed, the distribution of tortoises approximates to the former type, all the Side-necked group being confined to the Southern Hemisphere. Again, we find that whereas tropical Africa is closely related to tropical India as regards its Amphibians, while Australia and Africa are near akin to South America in regard to their tortoises, in respect of lizards there is no close connection between India and Africa, but an intimate relationship exists between India and Australia, where members of the same genera occur; while the Australian lizards are totally unlike their South-American cousins. As might have been expected from their great numerical preponderance at the present day, lizards appear to be a comparatively-modern group, their remains being rare in the lower Tertiary deposits, while in the Secondary period they are only known by a few species from the rocks of the Cretaceous epoch. That the group has originated from the tuateras, which were so abundant in the earlier strata of the Secondary period, may be regarded as most probable.

Habits

Turning to their mode of life, we find that while a few members of the order resemble crocodiles, in spending the greater portion of their time in water, visiting the land only for the purposes of feeding, sleeping, or basking in the sun, by far the greater majority of lizards are essentially land animals, avoiding even damp situations. Although some inhabit trees, the greater number dwell either on the ground or among the clefts of rocks, the conformation of the body generally giving some indication of this diversity of habitat. Among the land forms, for instance, those with depressed bodies are generally to be found in open sandy deserts, where they seek shelter either beneath stones or in holes; whereas such as have the body compressed are more usually dwellers among bushes or in trees. Those, again, in which the body is more or less cylindrical, are in the habit of secreting themselves in the clefts of rocks or the chinks of tree stems; while the snake-like kinds live on the ground, and those with a more worm-like form beneath the surface. The movements of the greater number of species—whether they live on the ground, among rocks, on trees, or on cliffs or walls—are agile in the extreme; and while the majority run with their bodies close to the ground, many habitually raise themselves up at times by resting on their hind-legs and tails, and are able to spring, either on the ground or from branch to branch, to a considerable distance after their prey. Of the arboreal species, some make use of their tails to aid in maintaining their hold, while others, together with cliff- and wall-hunting species, like the geckoes, are enabled to run along the under sides of boughs, or to ascend vertical surfaces by the aid of their expanded and disc-like feet. The peculiar flying lizard is enabled to take long, flying leaps, supported by a parachute-like membrane borne by the expanded ribs; while all the limbless species move somewhat after the manner of snakes, although making less use of the extremities of the ribs. The few aquatic forms swim and dive without the aid of webbed feet, but many other kinds swim well if thrown into water.

In many cases elegant and graceful in form, although at others rendered more curious than beautiful by the presence of spines or warts, lizards are pleasing rather than repulsive animals; and, with the exception of the American heloderms, none are poisonous, although some will bite sharply. Few lizards possess a distinct

voice, the majority merely uttering a low hiss; some, however, especially among those whose habits are nocturnal — emit a clear, sharp cry, which has been likened both to the scream of a frog, and to the chirp of a cricket. Of their senses, the most acute is doubtless that of sight, next to which probably comes hearing. In regard to diet, a few lizards are strictly herbivorous, but the great majority are more or less completely carnivorous; the larger kinds feeding on small mammals, birds and their eggs, other reptiles, and, more rarely, frogs and fish, as well as many descriptions of invertebrates. The smaller members of the order, on the other hand, are restricted mainly or entirely to an invertebrate diet, the great portion of which consists of insects, worms, and land mollusks. Nearly all drink by rapidly protruding and withdrawing the tongue; dew affording sufficient moisture to those living on rock or in trees, while some kinds can exist for long periods, or even entirely without drinking. The species inhabiting the warmer regions, save those which are arboreal or aquatic in their habits, pass the hottest and driest season of the year in a state of torpor; while those in colder regions regularly hibernate, such hibernation, in the case of some of the species inhabiting the continent of Europe, lasting for a period of from six to eight months. As regards their breeding habits, the majority of lizards lay eggs, which may vary from two to thirty in number, and have generally a soft and leathery covering, although sometimes furnished with a hard calcareous shell.

One peculiarity characterizing the members of the order cannot be passed over before concluding these introductory remarks. This is the facility with which they are enabled to reproduce lost parts, and more especially the tail. As is well known, in many lizards, when handled, the tail breaks off without any rough usage, and in all or nearly all it will readily come in two if pulled when the creature is seeking to escape, this susceptibility to automatic fracture being due to a cartilaginous band across the middle of each vertebra of the tail in the case of the common lizard of England. Such missing portion of the tail is speedily reproduced, it may be double; and whereas among the members of the typical family of the order, the scaling of the reproduced portion is like the original, in certain other forms this is by no means always the case. The remarkable circumstance about the matter is that when the pattern of the scaling of such a new tail differs from the original, it always reverts to that characterizing a less specialized and probably ancestral group. It is scarcely necessary to mention that in such an extensive assemblage as the present, only a comparatively-small percentage of species, or even genera, can be mentioned, and these but briefly.

THE GECKOES

Family *GECKONIDÆ*

Few creatures have given rise to a greater amount of fable and legend than the large group of lizards commonly known as geckoes; such legends being probably due to the nocturnal and domestic habits of these creatures, coupled with the sharp

chirping cry from which they derive their name, and their curiously expanded disc-like toes. Absolutely innocuous, they have been credited from the earliest times with ejecting venom from their toes, and of poisoning whatever they crawled over; while the teeth of one species have been asserted to be capable of leaving their impression on steel. Indeed, so intense is the dread inspired by these little creatures, that in Egypt the lobe-footed or fan-footed species is commonly termed *abu-burs*, or father of leprosy.

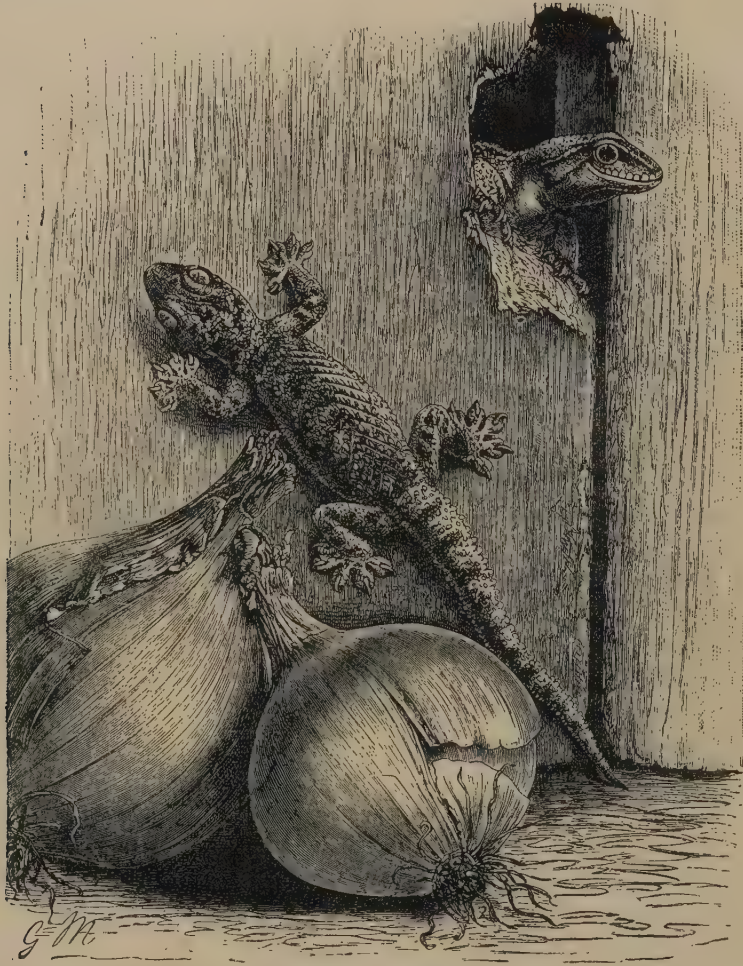
Geckoes, of which there are some two hundred and eighty species, distributed over all the warmer parts of the globe, although more numerous in the Indian and Australian regions than elsewhere, are for the most part small and plumply-built nocturnal lizards, characterized by their depressed form and dust-like coloration. The rather long and more or less flattened head is broad and triangular in shape; the large eyes are characterized by the absence of movable lids, and by the pupil being, except in a few diurnal forms, vertical; the aperture of the ears is likewise in the form of an upright slit. Externally, the head is covered with minute granules, or small scales, and the body is devoid of a bony armor, and in most cases covered above with granules, and beneath with small overlapping scales. If we add to the above features that the tongue is either smooth or covered with villous papillæ, and is short or moderate in length, and not sheathed at the base, and that the bodies of the vertebræ articulate by means of cup-shaped surfaces at both their extremities, we shall have said sufficient to distinguish the geckoes from all other members of the suborder. As regards their other external characteristics, the neck is very short and thick; the body, although rounded, markedly depressed, and the tail, which is generally remarkably brittle, usually thick and of moderate length, with its basal portion either



LOBE-FOOTED GECKO.

cylindrical or laterally compressed, although it may be leaf-like, or even rudimental. In some cases the tail is known to be prehensile, and it is not improbable that it is frequently endowed with this power. The limbs are generally remarkable for their shortness, and are always provided with five toes each, the tips or sides of which may be more or less dilated. In those species inhabiting desert regions, the toes are of normal form, being often nearly cylindrical, and keeled on their lower surfaces; but in the great majority of the members of the family, they are expanded either throughout their length or partially into adhesive discs, of which the under surface is formed by a series of movable symmetrical plates of variable form, by

the aid of which the creatures are enabled to ascend walls and run across the ceilings of rooms. In some cases the claws are retractile, either within the plates of the discs, or into sheaths, and in other instances the toes may be united by webs, which are not, however, for the purpose of swimming, all the geckoes being land lizards. The numerous teeth are small, and attached to one side of the summit of the jaw (pleurodont)



TURKISH GECKO.
(Natural size.)

**Lobe-Footed
Gecko**

The geckoes being so numerous in species, which are arranged under no less than forty-nine genera, it is of course impossible in a work like the present to do more than notice a few of the better known or more striking. Among these, one of the most familiar is the little lobe- or fan-footed gecko (*Ptyodactylus lobatus*) of Northern Africa, Arabia, and Syria. This is one of two species belonging to a genus characterized by the toes (as shown in the

figure on p. 2469) being dilated at their summits, where they are furnished inferiorly with two diverging series of plates; the digits being furnished with claws capable of retraction within notches in the front of the disc. The upper surface is covered with granules, among which are some small keeled tubercles; the color being grayish or yellowish brown above, with darker and light spots, and below uniform white. The length is a little over five inches.



FRINGED GECKO.
(Natural size.)

Turkish
Gecko

Equally well known is the Turkish gecko (*Hemidactylus turcicus*), represented in the figure opposite, which is likewise a small species, inhabiting the countries bordering the Mediterranean and Red Seas, and also found in Sind. It belongs to a group of genera with dilated toes and compressed claws, and is specially characterized by the extremities of the toes being free, the plates on the under surface of the discs arranged in double rows, and the

presence of some large shields on the under surface of the tail. Measuring not more than four inches in length, this species may be distinguished from the other European geckoes by the body being covered with from fourteen to sixteen longitudinal rows of warts, of which some are white and others blackish, and likewise by the hue of the upper parts being grayish brown spotted with flesh color. It is, however, said to be able to change its color according to circumstances, being of a shining milky white at night, and dark colored during the daytime. The genus to which it belongs comprises over thirty species, ranging over Southern Europe and Asia, Africa, tropical America, and Oceania.

Fringed Gecko A larger and more remarkable species is the one represented in the preceding illustration (*Ptychozoum homalocephalum*), which is the sole member of a genus characterized by the presence of an expansion of skin along the sides of the body, continued as lobes on the tail, as well as by the toes being completely webbed, and the inner one devoid of a claw. Attaining a length of nearly eight inches, this species has a distinctly ringed tail; its color above being grayish or reddish brown, marked with undulating dark brown transverse bands, and a dark streak extending from the eye to the first of the bands on the back. This gecko is an inhabitant of Java, Sumatra, Borneo, and the Malay Peninsula.

Wall Gecko The last member of the family we shall specially notice is the wall gecko (*Tarentola mauritanica*), which is the Mediterranean representative of a small genus ranging from the countries bordering the Mediterranean to West Africa, and including one West-Indian species. The genus is readily recognized by all the toes being dilated, and only the third and fourth furnished with claws. This species varies from rather less than five to somewhat more than six inches in length, of which one-half is formed by the tail. The sides of the neck and body, as well as the upper surface of the limbs, are ornamented with conical tubercles; the back carries seven or nine longitudinal rows of larger and strongly-keeled tubercles, and on the anterior half of the tail the ornamentation takes the form of knobs with backwardly-directed spines. The general color of the upper parts is grayish brown, with more or less distinct lighter and darker marblings, while a well-marked dark streak passes on each side of the head through the eye.

Habits With the exception of a certain number of species, the geckoes, as already said, are nocturnal in their habits, and many are remarkable for uttering shrill cries, probably produced by striking the tongue against the palate, which in some cases are compared to the syllables *jecko*, *checko*, or *toki*, and in others to the monosyllable *tok*. A South-African sand gecko is at times stated to occur in such numbers, and to produce such a din by its cry, as to render a sojourn in the neighborhood well-nigh insupportable. As regards their habitat, geckoes are very variable, some frequenting arid deserts, where they, in some instances, burrow in the sand; others frequent wooded regions, living either among low bushes or on trees, and concealing themselves during the day beneath stones or the bark of the stems; others again are found among rocks; while a third group has elected to live among human dwellings, where some of its members have become as fearless and confiding as domesticated animals. Of the arboreal species, the frilled gecko is

peculiar in having a parachute-like expansion of skin, which is used after the manner of that of the flying squirrels in aiding its owner to take long leaps from bough to bough. When at rest, the parachute is kept close to the sides of the body by the aid of its intrinsic muscles, and it is stated that this species, like several others, has the power of changing its color according to the hue of the object on which it is resting. The species frequenting houses may be divided into those which resort to



WALL GECKOES.
(Natural size.)

the interior, and those which are content with the outside. Of the latter, Sir J. E. Tennent writes that in Ceylon, "as soon as evening arrives, geckoes are to be seen in every house in keen and crafty pursuit of their prey; emerging from the chinks and recesses where they conceal themselves during the day, to search for insects that then retire to settle for the night. In a boudoir, where the ladies of my family spent their evenings, one of these familiar and amusing little creatures had its

hiding place behind a gilt picture frame. Punctually as the candles were lighted, it made its appearance on the wall to be fed with its accustomed crumbs, and, if neglected, it reiterated its sharp quick call of *chic, chic, chit*, till attended to. It was of a delicate gray color, tinged with pink; and having by accident fallen on a work table, it fled, leaving part of its tail behind it, which, however, it reproduced within less than a month. . . . In an officer's quarters, in the fort at Colombo, a gecko had been taught to come daily to the dinner table, and always made its appearance along with the dessert. The family were absent for some months, during which the house underwent extensive repairs, the roof having been raised, the walls stuccoed, and the ceilings whitened. It was naturally surmised that so long a suspension of its accustomed habits would have led to the disappearance of the little lizard, but on the return of its old friends, it made its entrance as usual at their first dinner, the instant the cloth was removed.' Another Indian observer, Colonel Tytler, writing of these house geckoes states that although several species "may inhabit the same locality, yet, as a general rule, they keep separate and aloof from each other; for instance, in a house the dark cellars may be the resort of one species, the roof of another, and the crevices in the walls may be exclusively occupied by a third species. However, at night they issue forth in quest of insects, and may be found mixed up together in the same spot; but on the slightest disturbance, or when they have done feeding, they return hurriedly to their particular hiding places." So far as is known, all the members of the family agree with the house geckoes in being insectivorous. With the exception of two peculiar New Zealand species producing living young, all the geckoes appear to lay eggs, which are inclosed in a round and hard shell, and are generally two in number.

A few peculiar geckoes, assigned to three genera, and of which
 Eyelid Hardwicke's gecko (*Eublepharis hardwicki*) is one of the best-known
 Geckoes examples, differ from the true geckoes in being furnished with movable
 eyelids, and also in that their vertebræ are articulated by means of cup and ball
 joints. Consequently, those eyelid geckoes, as they may be termed, form a distinct
 family — *Eublepharidæ*.

THE SCALE-FOOTED LIZARDS

Family *PYGOPODIDÆ*

To the ordinary observer it might well appear that the whole of the snake-like lizards, or those in which the body has become cylindrical and much elongated, and the limbs either rudimentary or wanting, would pertain to a single family. Such, however, is not the view of modern zoologists, who regard many of these aberrant members of the suborder as having been independently derived from several groups of fully-limbed forms, and thus having but little relationship among themselves. Of these snake-like groups, one of the most remarkable is that of the scale-footed lizards of Australia and New Guinea, which form a family comprising six genera, all characterized by the retention of more or less well-marked rudiments

of the hind-limbs, although the front pair have quite disappeared externally. According to the opinion of Mr. Boulenger, the scale feet come nearest to the geckoes, with which they agree in the essential characteristics of their skull, as they do in the nature of their tongue, the want of movable eyelids, and the vertical pupil of the eye; although the latter characteristic, as being variable in the geckoes, cannot be regarded as of much importance. Apart from their external form, they differ from the geckoes and thereby resemble the members of the next family in that the inner extremities of the collar bones are not expanded into a loop-shaped form, while they are peculiar in that the number of bones entering into the composition of each half of the lower jaw is reduced from six to four. The small and numerous teeth are closely set, and have generally long, cylindrical shafts, and blunted



COMMON SCALE-FOOTED LIZARD.
(Two-thirds natural size.)

summits; although in the genus *Lialis* they are sharply pointed, swollen at the base, and backwardly curved, thus resembling those of the monitors. The hinder limbs are represented externally by a scaly flap, which is most developed in the genus to which the figured example belongs; the component bones may be felt more or less distinctly, and the skeleton of the common species shows five toe bones.

The common scale-foot (*Pygopus lepidopus*), which attains a length of about twenty inches, and has a tail twice as long as the head and body, is the typical representative of the few members of this family. The head is long, pointed at the snout, and scarcely separated from the body, being covered above with large symmetrical shields, and on the sides with small scales. The ear has an oblique oval aperture, and the rudimental immovable eyelids are circular and covered with

minute scales. The cylindrical body is slender and of nearly equal thickness throughout, the scales on its upper surface, as in that of the long tail, being keeled. Larger in males than in females, the limbs have rounded extremities, and are enveloped in overlapping scales. In general color, this lizard is coppery gray above, sometimes marked with three or five longitudinal rows of blackish dots or elongate spots; the under parts being marbled gray, with the exception of the throat, which is white. Found both in Australia and Tasmania, and by no means uncommon in the warmer northern parts of Victoria, this lizard, like its kin, is stated to have habits very similar to those of the blindworm, although accurate observations on its mode of life are wanting.

THE AGAMOID LIZARDS

Family *AGAMIDÆ*

The southern and eastern portions of the Old World are the home of a very extensive family of lizards, comprising thirty genera and over two hundred species, which may be conveniently termed agamoids, from the name of the typical genus. Agreeing with the preceding families in the characteristics of the tongue, and in the absence of bony plates beneath the scales, the agamoids resemble the scale-foots in the characteristics of their collar bones; but are distinguished from all their allies having teeth of the acrodont type, that is to say, situated on the very summit of the edges of the jaws. While the head is covered with small scales, the small eyes have circular pupils and well-developed movable eyelids, and the scales on the back are of the normal overlapping type. The thick tongue is either completely attached or only slightly free in front, and, at most, has but a very shallow notch in its tip. The teeth may be generally divided into three series, comparable as regards position with the incisors, tusks, and molars of mammals; the latter being more or less compressed, and frequently furnished with three cusps, while the tusks, which may be one or two in number on each side, are of relatively-large size in most cases, although occasionally absent. The fore-limbs are always well developed, and, except in one genus, five toed. The absence of large symmetrical horny shields, both on the head and under parts, is a noteworthy character of these lizards, many of which develop, either in the males or in both sexes, ornamental appendages, such as crests or pouches. As a rule, the tail is long and not brittle, but in only one genus is it prehensile, although in another it can be curled up at the extremity. The shape of the body is very variable in the different genera, the terrestrial forms being generally depressed, while those that are arboreal in their habits are compressed. Although the majority of the species are insectivorous, some subsist on leaves and fruits, while others prefer a mixed diet; but neither the nature of their habitat nor their food serve to classify the agamoids, many of the genera of which are very difficult to distinguish. The majority of the species appear to lay eggs, only the members of a single genus being reported to give birth to living young. As regards distribution, agamoids are found from the south of

Europe to the Cape, and eastward as far as China, the Malayan Islands, Australia, and Oceania, but are unknown in New Zealand and Madagascar. Both as regards genera and species, their headquarters is, however, the Oriental region; Africa possessing only three genera, of which one is confined to the northern part of the continent, while but four species enter Southeastern Europe.

Flying Lizards Commonly known as flying dragons, the members of the first genus of the family are elegant and harmless little creatures to whom such a title seems inappropriate, and we therefore prefer to substitute the name of flying lizards—more especially as we have applied the former appellation to the extinct pterodactyles. These flying lizards, which are represented by twenty-one species, ranging over the greater part of the Oriental region, are at once distinguished from all their kindred by the depressed body being provided with a large wing-like membranous expansion, supported by the elongated extremities of the six or seven hinder ribs, and capable of being folded up like a fan. The throat is furnished with a large membranous expansion, on the sides of which are a smaller pair, and the tail is long and whip-like. The best known of the species is the Malay flying lizard (*Draco volans*), which is a rather common form, and belongs to a group characterized by the nostrils being lateral and directed outward; this particular species being distinguished by the absence of a spine above the eye, by the aperture of the ear being smaller than the eye, and by the inferior surface of the parachute being ornamented with black spots. In addition to the appendages on the throat, the males have a small crest on the nape of the neck; while in both sexes the back is covered with irregular, large-keeled scales, and its sides have a series of still larger scales, which are also keeled. In length it measures a little over eight inches. As regards coloration, the upper parts are of a brilliant but variable metallic hue, ornamented with small dark spots and wavy cross bands; between the eyes is a black spot, and a similar one occurs on the nape; the parachute is orange, with marblings or irregular cross bands of black, and the throat is mottled with black, its appendage being orange in the male and bluish in the female. This lizard inhabits the Malay Peninsula, Sumatra, Java, and Borneo, and in the living state is described as being so superlatively beautiful as to baffle description.

Essentially arboreal in their habits, the flying lizards generally frequent the crowns of trees, and as they are comparatively scarce, and seldom descend to the ground, they are but rarely seen. Describing the habits of the Malayan species, Cantor says that "as the lizard lies in shade along the trunk of a tree, its colors at a distance appear like a mixture of brown and gray, and render it scarcely distinguishable from the bark. There it remains with no signs of life, except the restless eyes, watching passing insects, which, suddenly expanding its wings, it seizes with a sometimes considerable, unerring leap. The lizard itself appears to possess no power of changing its colors." When excited, the appendages on the throat are expanded or erected, and the ordinary movements of the creature take the form of a series of leaps. After commenting on the fact that both flying lizards and flying lemurs inhabit the same countries, and have very similar modes of life, Moseley states that, when springing from branch to branch and from tree to tree, the former pass so rapidly through the air that the expansion of the parachute almost

escapes notice. Some examples kept on shipboard were in the habit of flying from one leg of a table to another. The females appear to lay three or four oval whitish eggs.

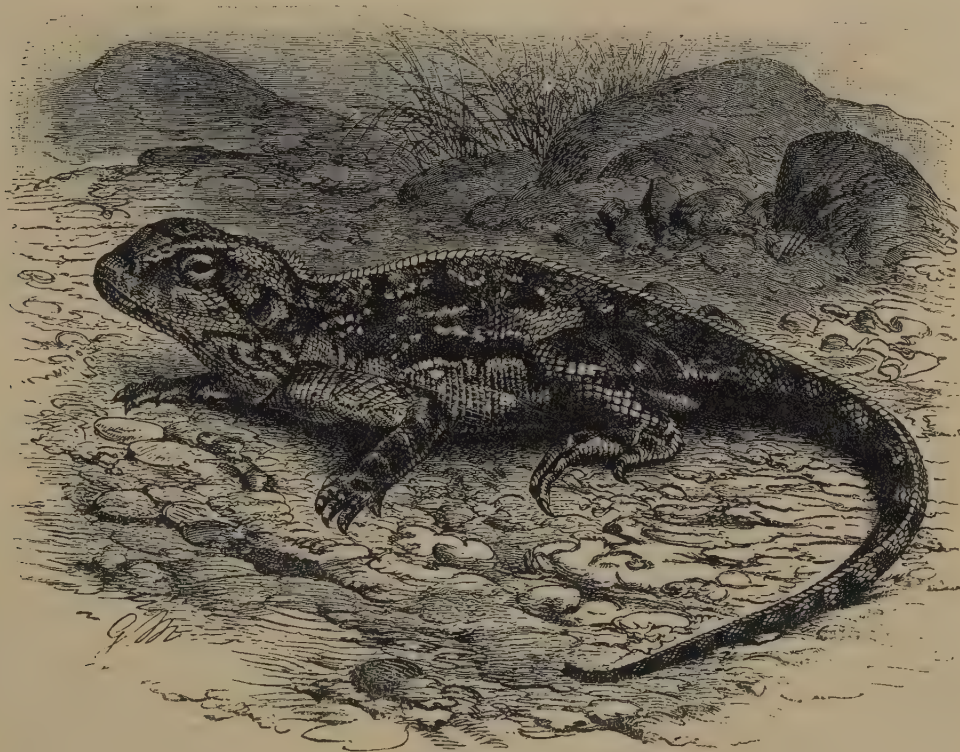
Among a number of genera, characterized by their more or less compressed bodies and generally arboreal habits, the numerous tree lizards constituting the genus *Calotes* may be selected for brief mention. These beautiful lizards belong to a group distinguished from many of their allies by the aperture of the ear being open, while they are especially characterized by the absence of any distinct fold of skin across the throat, by the equality in size of the large keeled scales on the back, and the presence of a large crest on the back and neck; the tail being very long and whip-like. One of the best-known species is the variable lizard (*C. versicolor*), ranging from Baluchistan, India, and Ceylon to the south of China, an exceedingly handsome lizard of some sixteen inches in length, with a very large crest, but so variable in color, when alive, as almost to defy description. It is one of the commonest of the eastern Asiatic lizards, and derives its name from its power of changing color, which is especially marked when it is sitting basking in the sun; the head and neck being often yellow, flecked with red, the body red, and the limbs and tail black. When irritated, or feeding rapidly, an allied species (*C. ophiomachus*) from India and Ceylon turns brilliant red over the head and neck, the body at the same time becoming pale yellow; hence it is popularly known as the "blood sucker."

Three remarkable lizards from Ceylon, constituting the genus *Ceratophora*, and belonging to a group in which the aperture of the ear is concealed, derive their name from carrying a more or less elongated horn-like process on the nose, at least in the male sex; the neck and back being devoid of a crest. One of the species, which attains a length of about ten inches, has a horn measuring half an inch. These lizards appear to be very rare, one of the species being confined to mountain districts.

For want of a distinct English title, we are compelled to designate the members of the genus *Agama* collectively by anglicizing their scientific name. Distinguished from all the previously-noticed forms and their allies, with the exception of the flying lizards, by their more or less depressed bodies, agamas are especially characterized by the exposed aperture of the ear, and the presence of large callous scales in front of the vent in the males. The crest on the back is, at most, but small, and may be wanting; while each side of the throat has a pit, and there is likewise a transverse fold across this part. A sac-like appendage may or may not occur beneath the throat, and the moderately-long tail may be either cylindrical or slightly compressed. Less important characteristics are to be found in the form of the head, which is short and triangular, very broad behind, and rounded at the muzzle, as well as in the relative length and slenderness of the limbs. The head is covered above with small, smooth scales; those on the back are overlapping and keeled; on the tail the scales may be either simply overlapping or arranged in whorls.

The distribution of the genus is somewhat peculiar, impinging on Southeastern Europe, and embracing the greater part of Southeastern Asia, as well as the whole

of Africa, but excluding India proper, together with Ceylon and Burma, although including the Punjab, Sind, and the Himalayas. As indicated by their depressed bodies, agamas are mainly ground lizards, generally frequenting barren localities or rocks, although a few species resort to shrubs. The circular pupil of their eyes is equally indicative of diurnal habits, and a large number of species are fond of basking on rocks in the full glare of the sun. In such situations, as in the valleys around Kashmir, they may be seen in numbers on almost every roadside mass of rock, where their extreme agility renders them very difficult to capture; the best method, according to the writer's experience, when specimens are required for preservation, being to strike with the lash of a hunting whip, whereby they are instantaneously stunned or killed. As regards food, all appear to be insectivorous.



ARMED AGAMA.
(Two-thirds natural size.)

From among rather more than forty representatives of the genus, **Armed Agama** three are selected for especial notice. The first of these is the armed agama (*A. armata*) of South Africa, which is represented in the illustration, and attains a total length of some twenty inches, of which rather more than six are occupied by the tail. Belonging to the second great group of the genus, or that in which the occipital or hindermost median scale on the top of the head is enlarged, this species is characterized by the spinose scales on the back being of unequal size,

by the aperture of the ear being larger than the eye, by the fifth toe being as long as the first, and the third slightly longer than the fourth, as well as by the scales, on the abdomen being keeled. Both sexes have a low crest on the nape of the neck, whereby the species is distinguished from most of its South-African congeners; while the males have two rows of twelve thickened horny scales in front of the vent. Although variable, this handsome lizard is strikingly colored. Generally the upper parts are olive brown, with the enlarged scales lighter; and there is a double series of darker blotches along the back, the under surface being lighter, and the throat marked with dark longitudinal streaks. Known to the natives of Mozambique by the name of *toque*, this species appears to feed chiefly on beetles, grasshoppers, and ants.

Very different in general appearance to the last species is the spinose agama (*A. colonorum*) of West Africa, which is a rather large form, and said to be the most common reptile met with on the Gold Coast. It differs from the preceding species by the shields on the back being of uniform size and furnished with spines, as well as in the absence of a crest. The body is not much depressed, and the sides of the head near the ear, as well as of the neck, are ornamented with radiating groups of short spines, which are at least equal to two-thirds the diameter of the ear opening. From an allied species (*A. rueppelli*) it may be distinguished by the scales on the back being very numerous, and considerably larger than those on the tail, the latter being strongly keeled and arranged in fairly-distinct rings. Attaining a length of rather more than thirteen inches, this species is noticeable for its brilliant coloration in the living state, although the hues rapidly fade away after death. When alive, the head is flame red, the throat spotted with yellow, and the body and limbs a deep steel blue, while along the middle of the back there is generally a whitish line. The lower surface of the basal half of the tail is yellowish, the corresponding upper portion steely blue, as is the tip, while the remainder is red. Very old specimens have, however, both surfaces of the base of the tail blue, the remainder of the upper surface, except a small blue tip, being red. Females are at all ages, much more soberly colored. In some spots these agamas are found in swarms, being very fond of climbing up the mud walls and mat roofs of the native huts, at times basking motionless in the sun, and at others running rapidly about in search of insects. When approached by a human being, they raise and depress their heads in a series of nods, which increase in rapidity as the intruder draws near, till, finally, the creatures lose courage and disappear, with the speed of lightning, into some crack or cranny. So brilliant do these gorgeously-colored lizards appear, when basking in the midday rays of an African sun, that the observer is fain to believe he is gazing on some splendid insect rather than a reptile.

Belonging to a group of the genus distinguished from the one containing the species described above by the absence of enlargement of the occipital scale of the head, the rough-tailed agama (*A. stellio*), depicted in the illustration on p. 2464, is interesting as being one of the two members of the genus whose range extends into Southeastern Europe. Whereas, however, the other members of the group have the tail more or less ringed, the rough-tailed

agama, together with the second European species (*A. caucasica*) and a third (*A. microlepis*), are peculiar in that the tail is divided into distinct segments, each composed of a pair of rings of scales. Growing to nearly a foot in length, the species under consideration is distinguished by its stout body and the moderate degree of depression of the head, the cheeks of the male being somewhat swollen. The color of the upper parts is olive, spotted with black, and generally with a series of large yellow, or olive spots down the middle of the back; the throat of the male having fine bluish gray net-like markings. Occurring in Europe, in Turkey, and certain islands of the Ægean sea, the rough-tailed lizard is distributed over the whole of Asia Minor, Syria, Northern Arabia, and Egypt, being much more common in the latter regions than it is in Europe. To the Arabs it is known by the name of *kardun*; and it is commonly tamed and kept in captivity by the itinerant snake charmers of Egypt. As shy and agile in its movements as its congeners, it feeds largely on flies and butterflies, which are captured with remarkable address and agility.

Before taking leave of this extensive genus, it may be mentioned that there is a third group, agreeing with the last in the small size of the occipital scale of the head, but distinguished by the absence of rings on the tail; the agile agama (*A. agilis*) of Persia being a well-known example. The genus *Phrynocephalus* of Southeastern Europe and Central Asia comprises rather more than a dozen lizards nearly allied to *Agama*, but easily distinguished by the concealed aperture of the ear.

**Australian
Frilled
Lizard**

Although the swollen callous scales in front of the vent in the males of the agamas have some resemblance to them, the whole of the preceding members of the family are characterized by the absence of true pores on this part of the body or on the thighs. In a second group such pores are, however, present in both, or in one or other of these situations; and we select as our first example thereof the remarkable frilled lizard (*Chlamydosaurus kingi*) of Australia — the solitary representative of its genus. This extraordinary-looking creature, which attains a length of nearly thirty-two inches, about eleven of which are taken up by the tail, is at once recognized by the curious frill-like membranous expansion surrounding the throat and extending upward to the sides of the nape. The frill, which is much more developed in the adult than in the young, has a serrated margin, and is covered with scales of larger size than those on the back; it irresistibly reminds one of the frills with which our ancestors were wont to adorn their throats, and communicates an altogether strange appearance to its owner. In form, the body of this lizard is slightly compressed, and although the scales of the back are strongly keeled there is no distinct crest in this region. The aperture of the ear is exposed, and the tail is either round or slightly compressed, the latter condition occurring in the adult male. The general color of the upper parts is pale brown, which may be either uniform or mottled with dark brown, or blackish mingled with yellow.

The frilled lizard is an inhabitant of Queensland and Northern and Northwestern Australia, as well as some of the islands of Torres Straits; its fossil remains occurring in the superficial deposits of the first-named district. Recent observa-

tions show that it inhabits sandy districts, where it walks, with a swinging gait, on its hind-legs, after the manner of the extinct iguanodon. When frightened, it sits down on its hind-quarters, raises its fore-quarters and head as high as possible, strikes its body with its tail, and shows its teeth at the intruder. Although the creature is perfectly harmless, this attitude has been known to frighten people who have seen it for the first time; and it probably has the same effect on other enemies. The frill which, when fully extended, forms a shield concealing the body, limbs, and tail, is moved by certain special muscles, and is supported by rods of cartilage.



SAIL-TAILED LIZARD.
(One-fifth natural size.)

Sail-Tailed
Lizard

Nearly allied to the preceding is the sail-tailed lizard (*Lophurus amboinensis*), which is likewise the sole member of its genus, and takes its name from the presence of a tall sail-like crest on the upper surface of the tail of the adult, which is supported by a great lengthening of

the spines of the vertebræ of that region. The body is markedly compressed, the back has a low crest, and the throat has both longitudinal puckerings and a transverse fold in the skin, while the aperture of the ear is exposed. In form, the head is short and thick, the compressed tail is long and powerful, and the legs and feet are also strong, the toes of the latter being covered inferiorly with small granular scales, and at the sides, especially externally, with a fringe of large united scales, which is one of the distinctive features of the genus. The covering of the upper parts is in the form of small quadrangular scales, which are keeled on the head and back. The dentition comprises six small conical teeth in the front of the jaws, four long tusks, and thirteen cheek teeth. On the thighs there is a row of pores. Attaining a length of over a yard, the sail-tailed lizard is of a general olive-brown color, becoming greenish on the head and neck, and spotted and marbled with black; while an oblique fold in the skin on the front of the shoulder is deep black.

Originally brought to Europe from Amboyna, this curious lizard is an inhabitant of the Philippines, Java, Celebes, and the Moluccas; it is arboreal in its habits, and is generally found in wood or scrub in the neighborhood of water. Its food consists of seeds, leaves, flowers, and berries, as well as worms, myriapods, and other creatures found in damp situations. If frightened, this lizard immediately dives into the water, and endeavors to conceal itself among the stones at the bottom, where, however, it may be readily captured with a net, or even with the hand, as it makes not the slightest attempt at defense. Its eggs are laid in the sand of the river banks. By the natives the creature is hunted for the sake of its flesh, which is white and well flavored, and consequently much appreciated.

Quite a different type of tail to that of the last is presented by the
**Thorny-
Tailed
Lizards** thorny-tailed lizards, of which there are seven species, inhabiting arid tracts in Northern Africa and Southwestern Asia. From the whole of the foregoing members of the present family, these lizards are sharply distinguished by the circumstance that the front teeth, instead of being small and conical, are large, and in the adult are united into one or two broad cutting teeth, separated from those of the cheek series by a gap; while externally they are easily recognized by their short tails covered with well-defined rings of spiny scales. The head is remarkably short and rounded; the body, as in most terrestrial members of the family, is much depressed, and there is no crest along the back. There are no folds or pouches on the neck, but pores are present both in front of the vent and on the thighs, and the aperture of the ear is exposed. The Arabian thorny-tail, or dabb, as it is termed by the Arabs (*Uromastix spinipes*), is one of the best-known members of the genus, and inhabits Egypt, Crete, and Arabia. It belongs to a group characterized by the rings of spiny scales on the upper surface of the tail being in juxtaposition; while, in common with two other species, it is specially distinguished by the circumstance that two or more transverse rows of scales on the lower surface of the tail correspond with one on its upper aspect. The Arabian species, which attains a length of about eighteen inches, differs from its two nearest allies in the minute size of the scales covering the body, coupled with the presence of a few scattered somewhat larger tubercular scales on the flanks. Its color is either sandy gray, or greenish above, which may be either uniform or clouded with

brown. The ornate thorny-tail (*U. ornatus*) of Egypt and Syria differs from the other three members of the first group in that the scales of the tail form complete rings, those on the lower surface being as long as those on the upper.

With the exception of one species (*U. microlepis*) inhabiting Persia, the members of the first group are confined to Africa, Arabia, and Syria, whereas the three



ARABIAN THORNY-TAILED LIZARD.
(One-third natural size.)

representatives of the second group are exclusively Asiatic, one (*U. loricatus*) being from Persia, the second (*U. asmusi*) common to Persia and Baluchistan, while the third (*U. hardwickei*) is an inhabitant of Baluchistan and Northern India. In the whole of these three Asiatic species the rings of spiny scales on the upper surface of the tail are separated from one another by rows of smaller smooth scales. In the

Indian thorny-tail the spines on the tail are small, with the lateral ones the largest; there are no enlarged tubercular scales on the back, and the front surface of the thigh is marked by a large black spot. In size this species is much inferior to its Arabian congener, not exceeding some eleven inches in length. Its color is either uniform sandy above, or the same spotted or mottled with a darker, and whitish beneath, with the aforesaid dark mark on the thigh.

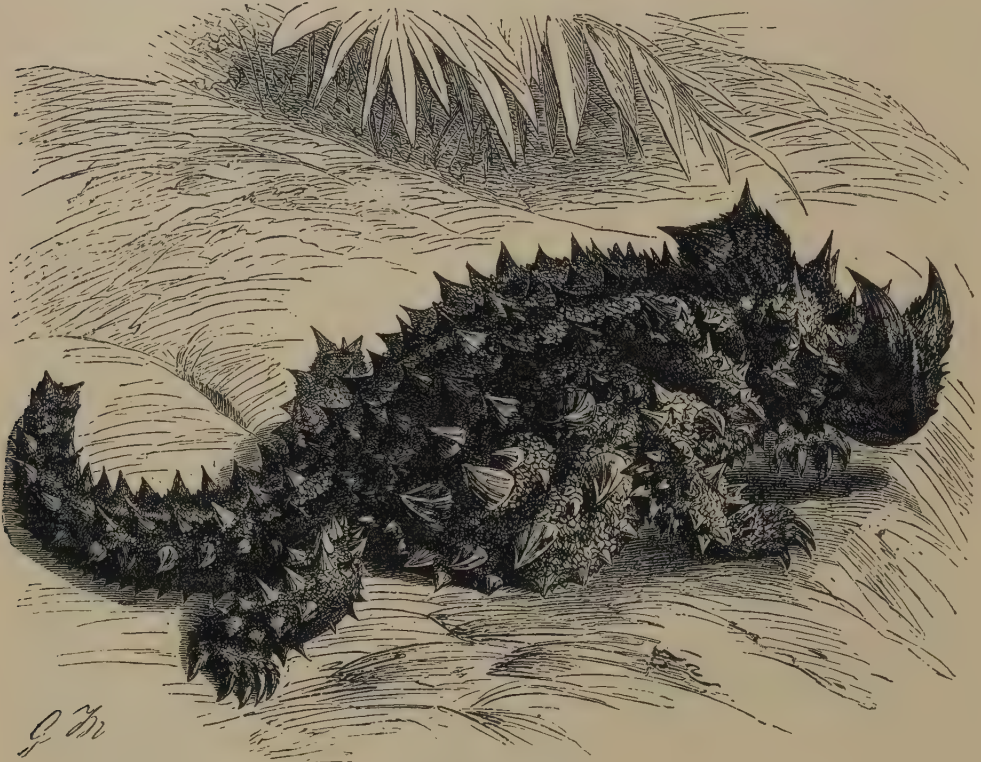
Habits

Conforming in their sombre coloration to the desert regions they frequent, the thorny-tailed lizards are entirely vegetable feeders, and live in burrows, resembling those of the smaller foxes, which are excavated by themselves. These burrows, which may be as much as four feet in length, sometimes turn almost at right angles to their original course, at a depth of a foot or so from the surface. Generally living solitary or in pairs, these lizards are met with abundantly in parts of Eastern Persia and the Punjab, and when approached at once make for their holes. If they succeed in getting their fore-limbs within the aperture of their borrows, it is impossible to pull them out, for, as the writer knows by experience, they will rather suffer their tails to be pulled from their bodies than to let go their hold. They are generally somewhat heavy and deliberate in their movements, turning their heads from side to side while walking, but are capable of running with tolerable speed. In the cold season, at any rate, they never leave their burrows till the sun is well up; and while in Persia and India they are commonly found on half-desert gravelly plains scattered over with low bush, the Arabian species is often met with in the clefts of rocks, whence it issues forth to bask on the smooth slabs or bowlders. According to Brehm, as many as a dozen of these lizards may occasionally be seen on a single slab of rock. All the species appear to be timid and gentle in their disposition, rarely, if ever, attempting to bite when captured. Their food comprises leaves and flowers, dried fruits, and the seeds of grass, as well as grass itself; but although in the wild state they never seem to touch animal food, in captivity the Indian species will greedily devour meal worms. According to Arab reports, the dabb never by any chance drinks, even when water is at hand, and this statement has been confirmed by modern observers. By the Arabs these lizards are frequently tamed and kept in captivity; and their flesh, which resembles that of young chicken, is much relished by them as an article of food. Nothing appears to be known as to their breeding habits. All the species thrive well in captivity in Europe. It is not improbable, according to Canon Tristram, that the reptile mentioned in Leviticus under the name of tortoise, is really the dabb.

Two nearly-allied lizards from East Africa—namely, *Aporoscelis princeps* from Zanzibar and Somaliland, and *A. batilliferus* from Somaliland,—while resembling the members of the preceding genus in general external characteristics, differ in the absence of true pores either on the under surface of the body or on the thighs, and are consequently referred to a distinct genus. Both appear to be rare, and are of comparatively-small size, the first named measuring only about seven and one-half inches in length.

Even more strange and uncouth in appearance than the frilled lizard, is another Australian species commonly known as the moloch (*Moloch horridus*), but termed

by the settlers the spiny lizard or thorny devil. This, the last remaining representative of the agamoids, differs from all the other members of the family in being covered with large conical spines, and in the conformation of its mouth and teeth. In all the forms previously described the mouth is large and the teeth of both jaws are erect, but in the moloch the mouth is very small, and the cheek teeth of the upper jaw are placed horizontally, with their summits directed inwardly. About eight inches in total length, this extraordinary lizard has a small head, with an extremely short snout, on the summit of which are pierced the nostrils; it has a much depressed body, a short and rounded tail, and



MOLOCH LIZARD.
(Natural size.)

thick, powerful limbs armed with strong claws. On each side of the head immediately above the small eye is a large horn curving outward and backward, while there is a smaller conical spine above the nostril, a second behind the horn over the eye, a third and larger one in front of each ear, as well as one on each side of the occiput. Between these spines the upper surface of the head is protected by small granular tubercles; while among the spines on the upper surface of the body, limbs, and tail, are similar granules intermingled with polygonal scales of which the edges are in apposition. On the back the spines form ten or more longitudinal series, of which the outermost are the largest. The lower surface of the body has a



THE BLACK IGUANA.

covering of rough, and slightly overlapping scales, among which are numerous rounded and keeled tubercles. In general color the creature is yellowish, ornamented with symmetrical chestnut or reddish-brown markings defined by darker borders.

Inhabiting Southern and Western Australia, and being not uncommon in several localities in the neighborhood of Port Augusta, the moloch is found only in districts where the soil is dry and sandy. Occasionally two or three may be observed basking in company on the top of a sand hill; and it is the frequent habit of this lizard to bury itself in the sand to a short depth below the surface. Its small eye and general manner indicate pretty clearly that the moloch is diurnal in its habits, although it may possibly occasionally move about during the night. Although generally very slow in its movements, it has been known, when disturbed, to make for a neighboring hole with considerable speed. In repose it generally rests with the head so raised as to be on the level of the back. Its chief food appears to be ants, although vegetable substances are sometimes eaten. The female deposits her eggs in the sand. To a certain degree the moloch is endowed with the power of changing its color to harmonize with its surroundings, such changes taking place very gradually, although not unfrequently. The most general change is to a uniform sandy slate, or russet color, when the ornamental markings almost completely disappear. In spite of its ferocious and somewhat forbidding appearance, the moloch is a perfectly harmless creature, its formidable-looking armor being never used for attack. In captivity it is dull and sluggish, undergoing fasts of a month's duration without any apparent inconvenience.

THE IGUANOID LIZARDS

Family *IGUANIDÆ*

The extensive family of lizards, of which the well-known iguanas of South America and the West Indies are the typical representatives, may be regarded as occupying the same position in America as is filled by the agamoids in the warmer parts of the Old World. Whereas, however, the agamoids are exclusively denizens of the Eastern Hemisphere, the iguanoid lizards are not absolutely confined to the western half of the globe, two genera occurring in Madagascar, and a third in the Fiji and Friendly islands. Although, with these exceptions, the family is unknown in the Old World, the same perverseness which causes Anglo-Indians to speak of the Oriental crocodiles as alligators, leads to the monitors of the Old World being commonly termed iguanas, although few lizards are more unlike than members of these two groups, both as regards external and internal characteristics. In their general structural features the iguanoids come very close to the agamoids. Thus in both groups the head is covered with numerous small shields; while the back is clothed with scales of different kinds, which are often arranged in oblique rows. Similarly, the eyes have round pupils and are furnished with well-developed

lids, and the drum of the ear is frequently exposed. Both groups, again, have two pairs of limbs, which may be relatively longer or shorter in the different genera, but are each provided with five toes. The length of the tail is subject to a large amount of variation, although it generally exceeds that of the head and body. Moreover, the two families resemble one another in the form and structure of the tongue, which is thick, short, scarcely notched, and generally fixed to the floor of the mouth throughout its length. When, however, we come to contrast the teeth of iguanoids with those of agamoids, we find a striking difference which at once serves to draw a sharp line of distinction between the two families. As we have already seen, in the latter group the teeth are attached to the very summits of the bones of the jaws (acrodont), and are commonly differentiated into front teeth, tusks, and cheek teeth. In the iguanoids, on the other hand, the tall and cylindrical teeth are attached by their sides to the outer wall of the jaws in the so-called pleurodont manner; the whole series being generally more or less uniform in character, and without any large projecting tusks. In the typical iguanas the teeth have somewhat diamond-shaped compressed crowns with serrated edges; and it was from a superficial resemblance to this type of tooth that the teeth of the great dinosaurian reptile from the English Wealden received the name of *Iguanodon*. A few genera, again, have the teeth divided into three lobes, thus resembling a fleur-de-lis. Many species of the family are further characterized by having teeth on the pterygoid bones of the palate, while a single genus is one of the few lizards in which there are teeth on the palatine bones.

The iguanoids, which comprise about three hundred species, arranged in fifty genera, may be regarded as especially characteristic of South and Central America, although they extend into the warmer parts of the northern half of that continent, ranging in the west as far as British Columbia, and in the east to Arkansas and the Southern United States, while they are also represented in many of the American islands. Their occurrence in Madagascar (where, as in America, agamoids are wanting) has been already mentioned, and it is probable that this remarkable instance of discontinuous distribution may be explained by the occurrence of fossil remains of species of the family in the upper Eocene rocks of France, where agamoids seem likewise to have been wanting.

Very variable in external appearance, iguanoids present equal diversity in their modes of life, and it is not a little curious that, with the exception of the flying lizard, almost every group of the agamoids finds a parallel, both as regards structure and habits, in the present family; the two families being thus representative groups. There are, however, certain iguanoids, such as the anolis lizards and the sea lizard which have no representatives in the preceding family. The majority of the iguanoids feed on insects, although some, like the true iguanas and the sea lizards, subsist on a vegetable diet, while one genus is stated to be omnivorous. Only two genera are known to produce living young.

In the forests, groves, and gardens of all the warmer regions of America live a number of beautiful lizards commonly known by the name of anolis, which is applied in the Antilles to some members of the group. The distinctive features of these lizards are the pyramidal form of the

Anolis

Lizards

head, the moderately-long neck, the presence of a broad and generally brilliantly-colored appendage on the throat of the males, the slender body, which may be either compressed, cylindrical, or slightly depressed, the relatively-long hind-limbs, the large feet, in which the toes are of very unequal length, and their middle joints expanded, with smooth transverse plates on the under surface, and the long, curved, and sharp claws, which are raised above the level of the expanded joints. The tail is long and hard, although not prehensile; the covering of very minute scales on the back and tail is not unfrequently elevated to form a crest; the cheek teeth are characterized by their distinctly tricuspid crowns; and teeth are generally present on the pterygoid bones of the palate. Lastly, these lizards possess the power of changing their color to even a greater extent than is the case with the



RED-THROATED ANOLIS.
(Natural size.)

chamæleons. From among more than one hundred species belonging to the genus we select for illustration the red-throated anolis (*Anolis carolinensis*), which inhabits the Southeastern United States and Cuba, and presents the following distinctive features. The head, which is long, triangular, and depressed, is nearly smooth in the young, but in the adult has well-marked frontal ridges, and some large rough shields on the crown; and the appendage on the throat of the males is relatively small. The body is not compressed, flat beneath, and not keeled above; the scales on its upper and lower surfaces being keeled and approaching an hexagonal form, with their edges either in apposition or slightly overlapping. The tail is cylindrical and tapering, with some slightly-enlarged scales on its upper surface, and

nearly equal to twice the length of the head and body. In the living animal the color of the upper surface is brilliant metallic green, and that of the under parts silvery white; the appendage on the throat of the males, which is covered with white scales, is red; there is a large blue eye-like spot above the axil of the forelimb; and the region of the tail is ornamented with black markings. In some specimens the green color passes more or less distinctly into brownish or brown; and when excited, the creature is able to change its general hue from greenish gray, through dark gray and brown of all shades, to the ordinary metallic green. In length this lizard varies from five and one-half to nearly nine inches, according to sex, fully two-thirds of these dimensions being taken up by the tail.

In Louisiana, Carolina, and Cuba, the red-throated anolis is one of the most common of lizards, and may be noticed in all suitable spots, such as woods and garden hedges, as well as the exteriors, and sometimes also the interiors of dwelling houses. Like their congeners, they are, however, to be met with most abundantly in the deep woods, and then so closely do they assimilate to their surroundings that their presence, when at rest on a bough, is generally only revealed by their brilliant eyes. In houses, these lizards exhibit but little fear of man, running about with the greatest unconcern in search of flies and other insects, and as, in addition to gnats, flies, butterflies, beetles, and spiders, they kill and eat wasps, scorpions, and other noxious creatures, their visits are encouraged. In motion throughout the day, they display extreme activity and speed, both when hunting among the foliage of trees or on the ground, pouncing upon their insect prey like a cat upon a mouse. In the spring, during the breeding season, the males display great jealousy of one another, so much so, indeed, that when two meet, a combat is certain to ensue, and is often continued till one of the combatants has lost its tail, which appears to be taken as an immediate sign of defeat. During these battles the appendage on the throat is inflated, and the changes of color are more rapid than at any other time. With the advent of summer, these mutual animosities are, however, forgotten, and these lizards dwell together in perfect amity, sometimes collecting in large companies. The females of some of the species are stated to dig a hole for the reception of their few white eggs with their fore-paws, at the foot of a tree or in some moist spot near a wall, afterward carefully covering them with soil to protect them from the sun's rays. The figured kind is, however, said to be very careless in regard to the place where its eggs are deposited; these being found either on bare sand or rocks, or even in rooms. The red-throated anolis, like most of its kindred, can be readily tamed, and makes a most charming pet, which can be without much difficulty transported to Europe. Writing of a pair which were at one time in his possession, Bell says that "I was in the habit of feeding them with flies and other insects, and having one day placed in the cage with them a very large garden spider, one of the lizards darted at it, but seized it only by the leg. The spider instantly ran round and round the creature's mouth, weaving a very thick web round both jaws, and then gave it a very severe bite in the lip, just as this species of spider usually does with any large insect it has taken. The lizard was greatly distressed, and I removed the spider and rubbed off the web, the confinement of which appeared to give it great annoyance; but in a few days it died, though previously in

as perfect health as its companion. The lizard was evidently unused to the wiles of the British spider."

The crested anolis (*A. cuvieri*), belonging to a small group with compressed and crested bodies and tails, is remarkable for the great extent to which the pouch on the throat can be inflated, — probably for the purpose of terrifying foes.

Allied Genera Two lizards, respectively from Jamaica and Columbia, differ from all the species of true anolis in having prehensile tails, in consequence of which they are referred to a distinct genus — *Xiphocercus*. In a third genus, *Chamælolis*, the cheek teeth have smooth and nearly spherical crowns.

Basilisks The strange form of the members of the present genus of iguanoids probably suggested to the earlier naturalists the imposition of the name basilisk, — a term which, as all our readers are doubtless aware, originally denoted a fabulous snake-like reptile before whose deadly glance every living being save the cock perished. Be this as it may, the reptiles now known as basilisks are large, although perfectly harmless members of the present family, belonging to a group distinguished from the preceding one by the absence of dilatation of the toes, and the more or less marked backward prolongation of the hinder portion of the head. In the presence of a large crest on the upper surface of the tail, the basilisks recall the sail-tailed lizards in the agamoid group, of which, indeed, they may be regarded as the representatives in the present family. As a genus they are characterized by the head in the adult males being produced backward into a large cartilaginous lobe; by the compressed form of the body and tail, which are covered with small overlapping scales, and by the presence of a crest on the back and tail in the males, such crests being always supported on the back by the prolonged spines of the vertebræ, and frequently also in the tail. Although there is a transverse fold on the throat, the pouch characterizing the anolis lizards is wanting. The long limbs are covered with keeled scales, and the outer sides of the hind-toes have a much developed lobe of skin. The cheek teeth have three-cusped crowns, and teeth are borne on the pterygoid bones. Internally, the basilisks form an exception to the members of this and the two preceding families in that the inner extremities of the collar bones have a loop-like expansion, as in the geckoes; while they differ from the anolis lizards in the absence of the false abdominal ribs so frequently present in this and the preceding families.

The basilisks are represented by four species from tropical America, among which the figured helmeted basilisk (*Basiliscus americanus*) is the one most commonly known. It is the largest representative of the genus, attaining a length of about thirty-one inches, of which nearly three-quarters is taken up by the tail; and is one of two species characterized by the great height of the crest of the tail in the males, which is supported by prolongations of the spines of the vertebræ. Inhabiting Panama and Costa Rica, it is specially characterized by the undivided head crest of the males; the scales on the under surface of the body are smooth. The natural color of the creature is probably green, although specimens preserved in spirit are olive brown above, and dirty white beneath. The back is marked with more or less distinct blackish transverse bands, while a lightish streak runs from the temple to the neck, and a more defined one from the region of the eye to the

fore-limb. The banded basilisk (*B. vittatus*), ranging from Mexico and Ecuador, represents a second group of the genus, in which the tail crest of the males is low, and not supported by bony rays. In this species the scales of the under surface of the body are keeled, whereas in the allied *B. galeatus* they are smooth. In general appearance all the basilisks suggest the idea of lizards upon whose backs has been grafted a fish's fin. As regards their habits, all the members of the genus



HELMETED BASILISK.
(One-third natural size.)

spend their time either on trees, or bushes, often basking in the sun on fallen stems, and seldom, if ever, venturing far from the neighborhood of water. Most numerous in the vicinity of rivers, basilisks are, indeed, so common in Guatemala, that the collector has no difficulty in obtaining as many specimens as he may desire, although the rapidity of their movements is so great that some practice is required to effect their capture. Their food is entirely of a vegetable nature, and

to gather this the basilisks are astir with the first rays of dawn, while during the heat of the day they prefer to rest among the most leafy boughs. At the slightest sound, they raise the head, inflate the throat, and elevate the crest, and as soon as the bright, yellow-irised eye detects the presence of a foe, the basilisks throw themselves instantaneously into the water above which they are usually reposing. In swimming, the head and neck are raised, the fore-limbs serve the part of propellers, while the crested tail acts as a rudder; hence the common name of "ferry-men" is applied to these lizards. At the end of April or beginning of May the female lays from twelve to eighteen eggs in some cranny at the foot of a tree, where they are left for the sun to hatch.

Nearly allied to the basilisks are the three species of ridge-headed lizards (*Corythophanes*) of Central America, characterized by the head being prolonged backward into a bony, helmet-like projection, while the tail is devoid of a crest, although the neck and back are provided with a low appendage of this nature. On the throat there is both a pouch and a transverse fold. The most interesting of the three species is the one named *C. hernandezi*, in which the head is crowned with a helmet-like prolongation so like that of the *chamæleon* that the creature is commonly spoken of under that name by the Mexicans. Like the anolis lizards, these reptiles are in the constant habit of changing their somewhat sombre colors, and it has been observed in a captive specimen that whereas the patch on the pouch was white during the day, at night it assumed, like the other light parts of the body, a blackish hue.

While agreeing with the basilisks in having the plates on the under surface of the toes distinctly keeled, there are a number of genera in the family distinguished by the absence of any backward prolongation of the crown of the head. Among these we select for mention the stilted lizards, specially characterized by the large size of the occipital shield of the head, the presence of a vacuity in the breastbone, the small or moderate-sized scales of the tail, the long and highly-curved toes, and the presence of tusk-like teeth in the jaws. There are but two representatives of the genus, both of which have a wide distribution in South America. The figured species (*Uraniscodon umbra*), which attains a length of about a foot, two-thirds of which are occupied by the long and cylindrical tail, has a short and frog-like head, raised into curved ridges over the eyes, with the muzzle very blunt, and the lower jaw longer than the upper. The skin of the neck is curiously puckered inferiorly, the folds forming a pair of pouches on the sides, although there is no pouch on the throat. In form, the body is at most but slightly compressed, with a low and slightly-serrated crest running from the nape down to the back; and the uniform scales of the back are small and overlapping, and those on the top of the head enlarged. The long and bent toes are markedly compressed, and are furnished with short but strong claws. In coloration this species is one of the handsomest of its tribe. The general ground color of the upper parts is reddish or purplish brown, ornamented with more or less distinctly defined blackish transverse bars; a broad black band traverses the fold in front of the shoulder, and may extend across the nape; while frequently in front of this band there is a large yellowish-orange spot on each side

of the neck. Below, the color is brownish or yellowish, which may be either uniform or clouded with brown markings. An inhabitant of the great primeval forests of South America, the stilted lizard has the power of changing color, and is consequently often designated a *chamæleon*. It generally associates in pairs, dwelling among trees, and its food appears to be entirely of a vegetable nature. When disturbed, it rushes suddenly up a high branch, where it stands with outstretched head and neck and widely-open eyes, gazing steadily at the intruder. Should it be unable to escape otherwise, the creature raises its neck still higher, inflates the neck pouches, and, with a sharp cry, springs boldly into the air.



STILTED LIZARD.
(Natural size.)

There are a very large number of genera, agreeing with those hitherto noticed in the absence of pores on the thighs, which the limits of our space prevent us from even mentioning. We accordingly pass on to the consideration of certain representatives of the second great group of the family in which such pores are present.

The Sea
Lizard

Both as regards their fauna and flora, the Galapagos islands stand altogether apart from the rest of the world, the greater number of their animals and plants being absolutely peculiar,—it may be specifically, or it may be generically,—while herbivorous reptiles take the place occupied on the continents of the world by vegetable-eating mammals. In no case, however, is this faunistic peculiarity more marked than in the occurrence in such a limited area of two distinct genera of the present family, each represented by a single species. Remarkable alike for special features connected with their dentition, as well as for their large bodily size, these two lizards differ widely from the rest of the family.

Whereas, however, the one is a land animal, the other is unique among the entire suborder to which it belongs in being a marine creature, subsisting on seaweeds.

Agreeing with the great majority of that section of the family characterized by the presence of pores on the thighs in the fourth hind-toe being longer than the third, the sea lizard, together with the terrestrial species inhabiting the same islands, differs from all the rest in that the front teeth resemble those of the cheek series in having three-cusped crowns, so that the entire set of teeth is uniform in character. From its terrestrial ally, the sea lizard (*Amblyrhynchus cristatus*) is distinguished by its much compressed and crested tail, as well as by the presence of



GALAPAGOS SEA LIZARD.
(One-sixth natural size.)

an incipient web between the toes. This lizard is the largest member of the family, and attains a total length of some fifty-three inches. It is characterized by the compressed form of the body and tail, and the extremely-short and truncated head. A well-marked crest runs from the nape of the neck to the tip of the tail, and the whole build of the animal is stout and "chubby." The throat is devoid of a pouch, although it has a well-marked transverse fold, and the toes are laterally compressed. In the small and convex head the nostrils are situated near the end of the muzzle, the eye and aperture of the ear are alike small, and the upper surface

is surmounted by a number of conical spine-like shields of relatively-large size. The investing scales of the body are small, and although keeled on the back, are smooth below. In the stoutly-made limbs the toes are rather short, the third one in the hind-foot being strongly serrated on its inner border of its basal joint. The compressed and crested tail is about equal to one and a half times the length of the head and body, and is covered with equal-sized keeled scales. In color this lizard is black or blackish brown above, with the abdomen and the inner surfaces of the thighs not unfrequently of a dirty white. In the young state, however, the upper parts are brown with paler spots, and more or less distinctly-marked dark cross-bars on the back. In weight, full-grown examples reach as much as twenty pounds.

The sea lizard is extremely common on the rocky coasts of the various islands of the Galapagos group, but is seldom found more than some ten yards from the shore. Of its habits Darwin writes than "this lizard swims with perfect ease and quickness by a serpentine movement of its body and flattened tail — the legs being motionless and closely collapsed on its sides. A seaman on board sank one, with a heavy weight attached to it, thinking thus to kill it directly, but when, an hour afterward, he drew up the line, it was quite active. Their limbs and strong claws are admirably adapted for crawling over the rugged and fissured masses of lava, which everywhere form the coast. In such situations, a group of six or seven of these hideous reptiles may oftentimes be seen on the black rocks, a few feet above the surf, basking in the sun with outstretched legs." After mentioning that the stomachs of several examples that were examined contained finely-minced seaweed, and also observing that the droves seen swimming out to sea were doubtless in search of food of this nature, the same author proceeds to state that, when frightened, these lizards absolutely refuse to enter the water. "Hence," he continues, "it is easy to drive these lizards down to any little point overhanging the sea, where they will sooner allow a person to catch hold of their tails than enter the water. They do not seem to have any notion of biting, but when much frightened they squirt a drop of fluid from each nostril. I threw one several times as far as I could into a deep pool left by the retiring tide, but it invariably returned in a direct line to the spot where I stood. It swam near the bottom, with a very graceful and rapid movement, and occasionally aided itself over the uneven ground with its feet. As soon as it arrived near the edge, but still being under water, it tried to conceal itself in the tufts of seaweed, or it entered some crevice. As soon as it thought the danger was past, it crawled out on the dry rocks, and shuffled away as quickly as it could. I several times caught the same lizard by driving it down to a point, and, though possessed of such perfect powers of diving and swimming, nothing would induce it to enter the water, and as often as I threw it in, it returned in the manner above described. Perhaps this singular piece of apparent stupidity may be accounted for by the circumstance that this reptile has no enemy whatever on shore, whereas at sea it must often fall a prey to the numerous sharks." Later observers have borne testimony to the extraordinary numbers in which the sea lizards are to be met with in the Galapagos, and likewise as to their food consisting mainly of broad-leaved sea leaves.

Galapagos
Land
Lizards

Although originally included in the same genus as its aquatic cousin there seems no doubt that the land lizard of the Galapagos (*Conolophus subcristatus*) is entitled to stand as the representative of a distinct generic group; the nearly cylindrical tail and perfectly free toes being distinctive characteristics which cannot well be overlooked. Not reaching within some eleven inches of the dimensions attained by the last, this lizard is likewise a stoutly-built creature, with the rather small head slightly longer than broad, the body somewhat depressed, a slight spiny crest on the nape, continued as a low ridge on the back, and the scales of the latter small and keeled, while the slightly larger ones



GALAPAGOS LAND LIZARD.
(One-fifth natural size.)

on the lower surface are smooth. Although devoid of a pouch, and with but a very slight transverse fold, the throat is strongly plicate longitudinally, and is covered with minute granules. The stout limbs terminate in very short toes, of which the third in the hind-foot is serrated on the inner margin of its basal joint. On the thigh the pores are arranged in a long series, and vary from seventeen to twenty-one in number. In length the tail scarcely exceeds the head and body, while in form it is slightly compressed, having a low ridge superiorly, and being covered with small keeled scales of uniform size. In general color the creature is dark brown, with the head and under parts lighter.

These lizards are confined to the central islands of the Galapagos group, such as Albemarle and James islands, where they are found in great numbers in the low barren districts near the coasts, although also met with in the elevated damp regions of the interior. On James island Darwin found them so numerous that it was difficult to obtain a spot free from their burrows on which to pitch a tent. Attaining a weight of from ten to fifteen pounds these lizards are lazy and sluggish in their movements, crawling slowly along with their bellies and tails dragging on the ground, and often stopping for a minute or two to doze with closed eyes, and the hind-limbs stretched out on the arid soil. According to Darwin's account, "they inhabit burrows, which they sometimes make between fragments of lava, but more generally on level patches of the soft sandstone-like tufa. The holes do not appear to be very deep, and they enter the ground at a small angle; so that when walking over these lizard warrens, the soil is constantly giving way, much to the annoyance of the tired walker. This animal, when making its burrow, works alternately the opposite sides of its body. One front leg for a short time scratches up the soil, and throws it toward the hind-foot, which is well placed so as to heave it beyond the mouth of the hole. That side of the body being tired, the other takes up the task, and so on alternately. . . . They feed by day, and do not wander far from their burrows; if frightened, they rush to them with a most awkward gait. Except when running down hill, they cannot move very fast, apparently from the lateral position of their legs. They are not at all timorous; when attentively watching anyone, they curl their tails, and, raising themselves on their front legs, nod their heads vertically, with a quick movement, and try to look very fierce; but in reality they are not so at all; if one just stamps on the ground, down go their tails, and off they shuffle as quickly as they can." If worried with a stick, these lizards will bite it severely, and when two are held together on the ground they will fight and bite till blood flows. "The individuals, and they are the greater number, which inhabit the lower country, can scarcely taste a drop of water throughout the year; but they consume much of the succulent cactus, the branches of which are occasionally broken off by the wind. I several times threw a piece to two or three of them when together, and it was amusing enough to see them trying to seize and carry it away in their mouths, like so many hungry dogs with a bone." They also eat the leaves of several trees, more especially of an acacia, to obtain which they ascend the low stunted trees, on the boughs of which they may often be observed quietly feeding. The females lay large eggs of an elongated form in their burrows; both these and the flesh of the lizards themselves being eaten by the inhabitants of the Galapagos.

True Iguanas The true iguanas, of which there are two closely-allied species from tropical America and the West Indies, differ from the two preceding genera in that the edges of the crowns of the cheek teeth are serrated, while the front teeth are simply conical. The distinctive features of the iguanas are to be found in the long and much compressed body, the large four-sided head, covered above with enlarged scales, the short neck, powerful limbs, long-toed feet, and the much elongated tail upon which the scales are uniform and keeled. The throat is furnished with a large nondilatable appendage, in front of which is a crest of large

compressed scales; and a continuous crest of long spines runs from the nape along the back, and is continued as a ridge on the tail. The scales on the back are small, equal, and keeled; the neck has some scattered large conical or bluntly-keeled tubercles, and there are also some large tubercular scales on the sides of the throat, more especially one below the aperture of the ear; while on the under parts the scales are either smooth or slightly keeled. The pores on the thighs are numerous, and, in addition to those in the margins of the jaws, there are teeth on the pterygoid bones of the palate. The common iguana (*Iguana tuberculata*) attains a length of as much as a yard and a half, two-thirds of which are occupied by the tail. The general color is green or greenish, becoming lighter on the under parts; but the upper surface may be either uniform or variegated with darker brownish bands, the flanks usually having light-edged vertical dark bars, while the tail has more or less distinct dark rings. There is frequently a whitish band in front of the arm, and some of the large tubercular scales on the sides of the throat and neck are often light colored.

Both species of iguanas, of which there are several varieties, are essentially arboreal lizards, generally frequenting those regions of the forests where the trees overhang the water. Here they move with great agility, climbing or springing from bough to bough, while the harmony of their coloration to their surroundings renders them well-nigh invisible. Toward evening they not unfrequently descend to the ground to feed; but, when frightened, immediately rush to the topmost boughs of the trees, or plunge headlong into deep water. In the latter element they are, indeed, perfectly at home, and swim strongly and swiftly, with their limbs closely applied to their bodies, and impelled by their powerful tails. They are likewise expert divers, frequently remaining for a considerable time below the surface; their activity in the water being such that they are able to avoid all enemies save crocodiles and caimans. Their chief food consists of leaves, flowers, and berries, although they will also eat insects; the numbers of small worms sometimes found in their stomachs having probably been swallowed accidentally. Generally seeking to escape at once from human beings, iguanas when unable to flee show fight, erecting their heads and assuming a fierce aspect, while at close quarters they bite savagely and administer severe blows with their powerful tails. The female deposits from eight to seventeen eggs in a hole dug in sandy soil, but as several individuals will not unfrequently lay together, as many as ten dozen eggs may be found in a single nest. In spite of their somewhat repulsive appearance, iguanas are hunted for the sake of their flesh, which is white in color and delicate in flavor, and is said to resemble the breast of a chicken. The eggs also, which consist almost entirely of yolk, are highly esteemed as articles of diet. Iguanas are generally captured by means of nooses, which are thrown over their heads as they repose on the branches. The much smaller horned iguana (*Metopoceros cornutus*) of San Domingo constitutes a separate genus, distinguished by the presence of an inflatable pouch on the throat.

The West-Indian ring-tailed iguana (*Cyclura carinata*) is selected to represent a group of genera distinguished from the foregoing by the crowns of the cheek teeth being three cusped or simply conical. While four of these genera—among which is the Fijian iguana (*Brachylophus*

Ring-Tailed
Iguana

fasciatus)—are characterized by the shortness of the row of pores on the thigh, the present species is one of those in which they form a long series; and it is further characterized by the presence of a serrated crest down the back and tail, and also by a pouch and slight transverse fold on the throat. The head is large, swollen below the ears, and furnished with enlarged scales on the snout; while the body and tail are compressed, the body being covered with small scales. The species derives its name from the rings of keeled scales which form regular segments on the sides of the tail, each segment being composed of from three to five series of



RING-TAILED IGUANA.
(One-fourth natural size.)

small scales, and a single series of larger and somewhat spinous ones. The toes are compressed, and covered below with keeled plates. In total length this iguana reaches about forty-eight inches; and its general color is green or dark olive, speckled with darker and lighter, and frequently marked with blackish transverse bands. The ring-tailed iguana is a somewhat local species, occurring most abundantly in Jamaica, on the limestone mountains in the neighborhood of Kingston harbor and Goat island, but also met with on the low grounds lying between the coast ranges and the higher mountains of the interior, where hollow trees occur. Shy and retiring in their habits, the creatures live in pairs, and display no great

partiality for water, although, on occasion, they can swim as well as the true iguanas. They feed mainly or entirely on grass, and when disturbed in grazing, these reptiles rush back to the trees with extraordinary speed, sometimes taking great leaps like a frog, although their movements are generally deliberate and slow. If unable to escape, they show fight in much the same way as the true iguanas. The breeding habits of this species do not appear to be known, although the females of the allied black iguana (*Ctenosaura acanthura*) of California are in the habit of laying in company, like the true iguanas. The ring-tailed iguana exhales a peculiarly disagreeable smell, which is stated to be so objectionable as to cause even the ants to forsake a room into which one of these creatures is brought. For this reason its flesh is uneatable, although that of the black iguana is highly esteemed.

Extinct Iguanas We have not hitherto mentioned that the vertebræ of the iguanoid lizards differ from those of the agamoids and most other members of the suborder in being furnished with additional articular facets like those of snakes. Vertebræ of this peculiar type occur in the upper Eocene rocks of England and the Continent, and have been provisionally assigned to the typical genus *Iguana*, although it is more likely that they indicate an extinct genus. Somewhat similar vertebræ from the corresponding strata of the United States have been described under the name of *Iguanavus*.

Horned Lizards The last and at the same time the most peculiar members of the present family are the horned lizards of North America and Mexico, which may be regarded as the representatives of the moloch lizard among the agamoids. From their short, rounded heads, abbreviated bodies, and shortened tails, coupled with a general batrachian appearance, these lizards are commonly termed toads in America, the popular name of the figured species (*Phrynosoma cornutum*) being the Californian toad. Strange, not to say ugly, in appearance, these lizards are at once distinguished from all their allies by the presence of several bony spines projecting from the back of the shortened head, and of tubercles or spines scattered among the ordinary scales of the body. In form, the body is broad and depressed, without any crest down the back; and the tail is very thick at the base and never longer than the body. The limbs are rather long, with pores on the thighs, and keeled plates on the lower surfaces of the toes. From most other members of the family these lizards are further distinguished by the absence of teeth on the palate. Of the twelve species of the genus the best known is the common horned toad, herewith figured, which has the tail longer than the head, distinct spines on the back, and the drum of the ear naked. Its general appearance is even more than superficially toad-like, the head being as broad as long, and the body being remarkable for its extreme plumpness. Measuring a little over five inches in length, this species is rather handsomely colored. Above, the ground color is grayish or brownish, with a more or less well-marked light stripe down the back, and dark brown spots at the bases of the larger spines; there are likewise markings of the same color on the nape and head. Beneath, the hue is yellowish, with or without a few small brown spots. In two species of the genus (e. g. *P. taurus*) the tail does not exceed the head in length. The common species

is found locally in sandy districts both on the plains and mountains, and is in some places abundant, although from its coloration frequently escaping notice. In spite of its somewhat formidable appearance, it is a harmless creature, not attempting to bite even when captured. Lacking the protrusive tongue of the *chamæleon*, and being debarred by its clumsy form from running fast, the horned lizard is unable to capture the swifter insects, and consequently preys upon sand-haunting beetles, whose speed is inferior to its own, such prey being generally captured in the evening, and the creature lying passive on the sand during the day. Some species of horned lizards are remarkable as being the only members of the family, save one other genus, which produce living young; the number of young being in some instances as many as twenty-four. Always small feeders, these lizards are capable



HORNED LIZARD.
(Three-fourths natural size.)

of undergoing long fasts with impunity; and as they are habituated to a dry atmosphere, and probably never drink, they may be sent packed in wadding long distances by post.

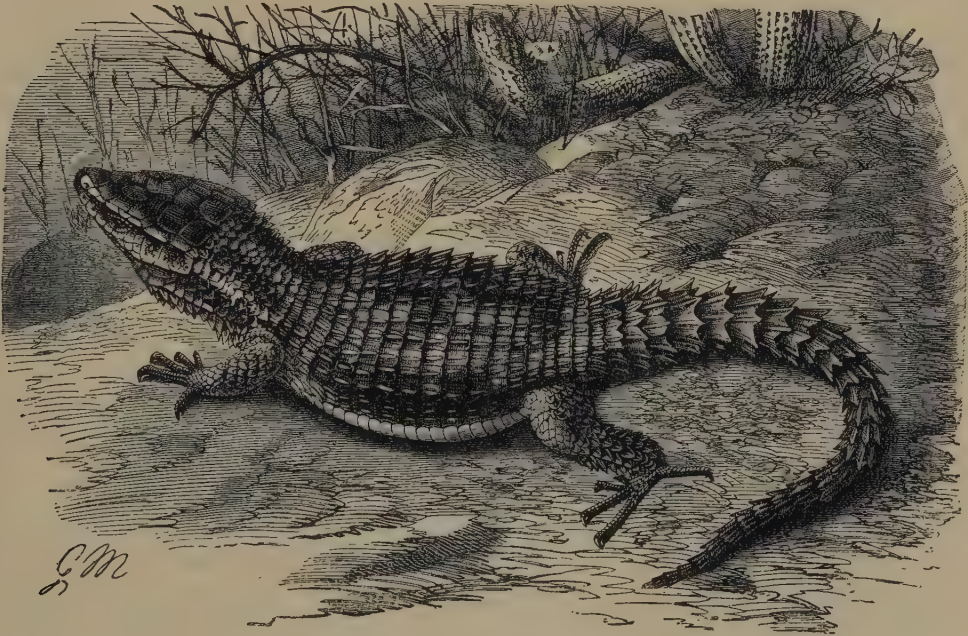
The most remarkable peculiarity connected with these lizards is their habit of ejecting jets of blood from the eyes, apparently as a means of defense. The following letter from Mr. V. Bailey, written from California, in 1891, describes the phenomenon as first observed by him: "I caught a horned toad to-day that very much surprised Dr. Fisher and myself by squirting blood from its eyes. It was on smooth ground, and not in brush or weeds. I caught it with my hand, and just got my fingers on its tail as it ran. On taking it in my hand, a little jet of blood spurted from one eye, a distance of fifteen inches, and spattered on my shoulder.

Turning it over to examine the eye, another stream spurted from the other eye. This it did four or five times from both eyes, until my hands, clothes, and gun were sprinkled over with fine drops of bright red blood. I put it in a bag and carried it to camp, where, about four hours later, I showed it to Dr. Fisher, when it spurted three more streams from its eyes." The phenomenon has been subsequently observed in other specimens.

THE GIRDLED LIZARDS

Family *ZONURIDÆ*

Omitting mention of a family represented only by one genus (*Xenosaurus*) and one species from Mexico, the next group for consideration is that of the girdled lizards, from tropical and South Africa, and Madagascar, of which there are four genera. These lizards, which may be either snake-like in form, or provided with four



CAPE GIRDLE-TAILED LIZARD.
(Natural size.)

fully-developed limbs, differ from all those hitherto described, with the exception of certain geckoes, in having the temporal fossæ of the skull roofed over with bone; while they are further characterized by a fold covered with small scales running along the sides of the body and marking off the upper from the under parts. The tongue is simple, with its anterior moiety not extensile, and its tip either rounded,

or but slightly notched; while there are well-developed eyelids, and the drum of the ear is exposed. The back is either clothed with large shield-like, and mostly-keeled scales, arranged in well-marked transverse zones, or, more rarely, with granules, the head having large, regular shields. As regards their teeth, these lizards conform to the pleurodont type, each tooth having its base widely open. Resembling in many respects the Iguanoids, from which they are distinguished by the ossifications in the skull, these lizards also approach the members of the next family, from which they differ by their simple tongues, the hollow bases of the teeth, and the structure of the bony plates underlying the scales, when such are present. In the South-African snake-like genus (*Chamæsaura*) the fore-limbs are wanting, and the hind pair rudimental, while the tail is of extraordinary length. All the members of the family appear to be carnivorous.

**Girdle-Tailed
Lizard**

We take as our special example of this small family one of the members of the South-African girdle-tailed lizards (*Zonurus*), a genus represented by seven species. These lizards differ from the other three genera in having the scales of the back underlain by bony plates of simple structure; and, resembling in appearance the rough-tailed lizard among the agamoids, they have a flattened triangular head, and a tail of moderate length. On the upper surface the neck and back are covered with large quadrangular shield-like scales, while beneath there are large flat shields; the limbs bearing keeled overlapping shields, and the tail being protected with whorls of spinous scales. The teeth are small, and the rounded tongue is scarcely notched. The figured species (*Z. cordylus*), which attains a length of rather less than eight inches, generally has the back and tail of a dirty orange color, the head and feet of a lighter yellow, and the under parts white, although there are considerable variations from this normal coloration. All the members of the genus inhabit rocky districts, and prefer those where there are ledges, upon which they run in search of food or warmth. They are excellent climbers, and far from easy to catch, often leaving their tails with their would-be captors.

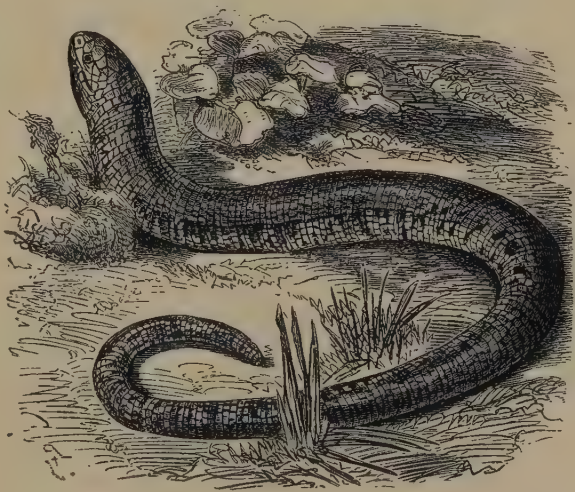
THE SNAKE-LIKE LIZARDS.

Family *ANGUIDÆ*

Nearly allied to the preceding family is a small group of lizards of variable bodily form, typified by the common English blindworm. Rigid in their bodies, and having large symmetrical bony shields on the top of their heads, these lizards resemble the girdle lizards in the presence of bony plates beneath the overlapping scales, and also in that the temporal fossæ of the skull are roofed over with bone. They differ, however, in that the bony plates beneath the scales are permeated by a series of radiating or irregularly arranged canals; and also in the conformation of the tongue. The latter is composed of two distinct portions, namely, a thick basal half, covered with villose papillæ, and a smaller thin terminal moiety coated with scale-like papillæ, which is extensile, and capable of partial withdrawal into a sheath

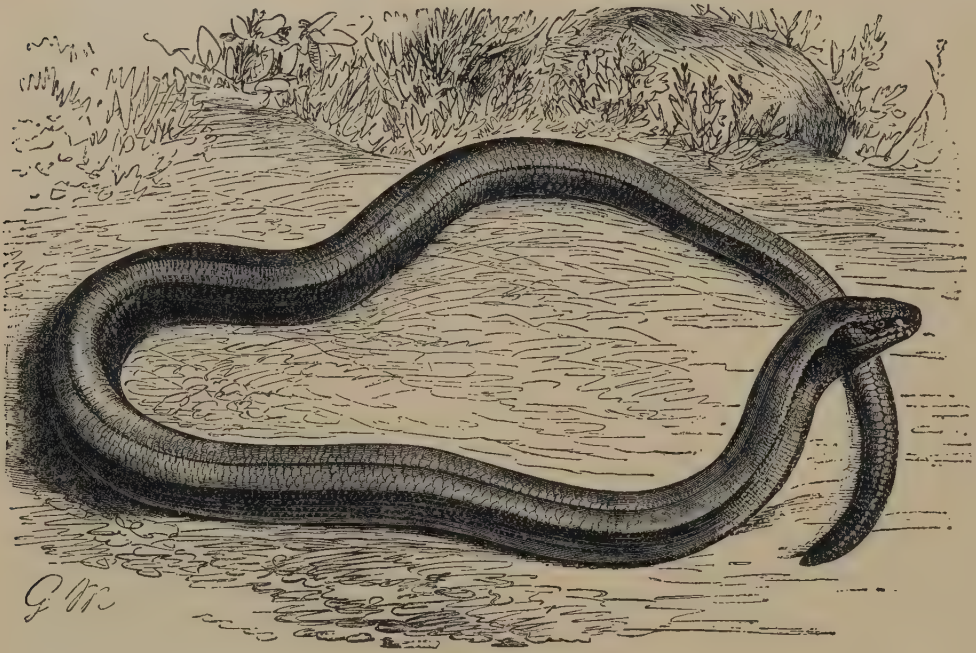
formed by a transverse fold at the front of the basal half. As regards their dentition, some forms have tubercular or conical teeth attached to the sides of the walls of the jaws in the typical pleurodont manner; but in the blindworms the teeth are long, curved, loosely-attached fangs, very like those of serpents. Instead of hollowing out the bases of the old teeth, as in the preceding family, the new ones grow up beneath them; and there may or may not be teeth on the bones of the palate. Some of the members of the family agree with the preceding in having a longitudinal fold along the sides of the body, while in others it is absent; and there is a similar variation in external form, some genera having fully-developed five-toed limbs, while in others all external traces of these appendages have disappeared. In regard to the covering of the head, it should specially be noticed that there is a large occipital shield at its hinder extremity. All the species differ from the majority of lizards in changing their skin in a single piece, like most snakes. With the exception of some species of the American genus *Gerrhonotus*, which ascend low bushes, all these lizards live on the ground; and the whole of them are carnivorous, the larger species preying on reptiles and other vertebrates, and the smaller kinds on insects, spiders, slugs, and worms. While the blindworms produce living young, the others lay eggs. Containing seven genera and some forty-five species, this family is most numerously represented in Central America and the West Indies, a few species occurring in North and South America, two in Europe, and one in the Himalayas and Burma; all the forms with functional limbs being American. From limitations of space, our notice of the family will be confined to two of the snake-like genera.

The typical representative of this genus of snake-like lizards *Scheltopusiks* (*Ophisaurus apus*) was first discovered by Pallas in the wooded valleys of the steppes bordering the Volga, where it is known, in common with true snakes, by the name of scheltopusik, a term which may be conveniently applied to all the members. The species was subsequently discovered in other parts of Russia, as well as in Hungary, Istria, Dalmatia, Greece, Asia Minor, Syria, Persia, Transcaucasia, Transylvania, and Turkestan, while it is replaced in Morocco by a more brilliantly-colored variety. Four other species are also known, which extend the range of the genus to Northeastern India, Burma, and North America. Agreeing with the American four-limbed genus *Gerrhonotus* in the presence of a fold along the sides of the body, and the



COMMON SCHELTOPUSIK.

more or less conical teeth, the scheltopusiks are distinguished by their moderately elongated snake-like form, and the absence of functional limbs; the European species alone having the hinder pair represented by minute rudiments on the sides of the vent. These creatures are covered with squared scales, arranged in straight longitudinal and transverse series; and they are furnished with teeth on the pterygoids, and in certain cases on some of the other bones of the palate. The European species, which, in addition to rudiments of hind-limbs, is distinguished by an aperture to the ear, attains a length of rather more than a yard, of which about two-thirds are occupied by the tail. The arrangement of the shields on the head is very much the same as in the blindworm; and the general color is



THE BLINDWORM.
(Three-fifths natural size.)

brown, becoming lighter on the lower surface. The young are, however, olive gray, with wavy dark brown cross bands on the back, and bars on the sides of the head. Dwelling among the dense underwood of thickly-wooded valleys, the scheltopusik harmonizes so closely in color with its surroundings, that it can only with difficulty be detected, as it glides away among the dead leaves and sticks at the approach of a footstep. Although as free from venom as ordinary lizards, it is frequently mistaken for a snake, and then meets the fate which so often, under similar circumstances, befalls the blindworm. Preying largely upon mice and voles, and not even hesitating to attack and kill the deadly viper, the scheltopusik is, however, a fierce and active creature, gliding swiftly and suddenly upon its victims among the moss and leaves of the woods. It also subsists largely upon

snails; and is further reported to eat the eggs and young of birds. Its eggs are laid under thick bushes and leaves. The scheltopusik is believed to be a long-lived animal, the natives of the countries it inhabits stating that its full period of existence is from forty to sixty years. Fossil scheltopusiks occur in the Miocene deposits of Germany, some of which belong to an extinct genus (*Propseudopus*).

The want of a lateral fold along the body distinguishes the blindworm, or slowworm (*Anguis fragilis*), in common with the remaining members of the family, from the scheltopusiks; the blindworm being further distinguished from the other genera devoid of this fold by the absence of all external trace of limbs, and the fang-like form of its cheek teeth. The appearance of the blindworm, which, by the way, is the sole representative of its genus, is so well known as not to call for much description. It may be observed, however, that the scales are rounded in form, and arranged on the back in a quincuncial pattern, while on the sides they are disposed in transverse rows; the ears are usually covered with integument; and the palate is toothless. Attaining a length of from ten to twelve, or even fourteen, inches, of which at least half is occupied by the tail, the blindworm is of almost equal thickness throughout, although tapering slightly at the tail. The head is short and small; the eyes, although minute, are bright and piercing; and the tongue is but slightly notched. In the immature state the upper parts are silvery, with a dark line down the middle of the back, while the sides and under parts are blackish. The markings, however, often disappear in the adult, or may be replaced by dark dots, the upper surface becoming at the same time brown or bronzy. The range of this species includes Europe, Western Asia, and Algeria.

Gentle and inoffensive in its habits, and rarely attempting to bite even when rudely handled, the blindworm is commonly regarded as one of the most noxious of reptiles. When captured, it usually contracts its muscles so forcibly as to become perfectly rigid, in which state it easily breaks if bent or struck, thus giving origin to its Latin name. Generally frequenting woods, heaths, and commons, the blindworm is one of the hardiest of British reptiles, making its appearance in the spring at an earlier date than any other kind. According to Bell, "it retires in the autumn under masses of decayed wood or leaves, or into soft, dry soil, where it is covered with heath or brushwood, and penetrates to a considerable depth in such situations by means of its smooth, rounded muzzle and polished body." It feeds chiefly upon slugs, supplemented by various insects and worms. In June or July the female produces from seven to twelve or thirteen living young, which are active almost immediately after birth, and soon learn to feed by themselves. Like other viviparous reptiles, the female is much given to basking in the sun during the period of pregnancy, in order that its heat may aid in developing the eggs contained in her body.

THE POISONOUS LIZARDS

Family *HELODERMATIDÆ*

Two conspicuously-colored lizards, ranging from the isthmus of Tehuantepec in Central America as far north as New Mexico and Arizona, stand alone in the suborder in being poisonous, their bite, in certain cases at least, being sufficiently severe to produce very serious symptoms even on human beings, while smaller animals are soon killed thereby. These two species are the Mexican poisonous lizard (*Heloderma horridum*) of Western Mexico, and the Arizona poisonous lizard (*H.*



ARIZONA POISONOUS LIZARD.
(One-third natural size.)

suspectum) from New Mexico and Arizona, the former being known in its native country by the name of silatica. Nearly allied to the blindworm, which they resemble in the general structure of their tongue and teeth, although distinguished by certain peculiarities in the conformation of the skull, and by the upper surface being covered with small granular tubercles, externally they are characterized by the depressed head, the plump, rounded body, the tolerably long cylindrical tail, the rather short limbs, in which the third and fourth toes are longer than the others,

the exposed drum of the ear, and the transverse arrangement of the rows of tubercles on the upper surface. The curved and fang-like teeth are but loosely attached to the jaws, and have grooves in front and behind for the transmission of the poison, while there are also teeth on the palate. Beneath, the body and tail are covered with squared scales. In length, the figured species measures rather less than twenty inches, while the other is somewhat larger. The former has a yellowish or orange ground color, marked with a dark network on the head and body, and with blackish rings on the tail. Among the reddish sand, intermixed with dark pebbles, in which these lizards delight to nestle, this coloration, coupled with the granular nature of the skin, appears to be protective.

Inhabiting dry regions from the western side of the Cordillera to the Pacific, and apparently never entering water, the poisonous lizards are nocturnal in their habits, lying during the day hidden among the vegetation in a listless state, and issuing forth at evening. Their movements are at all times deliberate; and as these lizards are most commonly met with in the wet season, being but seldom seen during the dry months from November to June, it is probable that they are torpid during part of the latter period. Their food comprises insects, worms, myriapods, and small frogs, as well as eggs of iguanas. Regarding the effects of their bite, Sir J. Fayrer writes that he once saw two guinea pigs bitten by one of these lizards. "The bites were viciously inflicted, and the lizard did not really relinquish its hold. Blood was drawn, the teeth being deeply inserted. Both guinea pigs were affected; the bitten limb was dragged, and appeared partially paralyzed. There were twitchings of the body generally, but these may not have been due to the poison, but to agitation and fear." Both the unfortunate rodents died in the course of the day. Another of these lizards once bit its owner, who was incautiously handling it, with very severe effects, which did not, however, prove fatal. The poison is secreted in special glands situated near the roots of the teeth.

THE MONITORS

Family *VARANIDÆ*

No better instance of the essential difference in the distribution of lizards as compared with tortoises is afforded than by those lizards commonly known as monitors. The tortoises of Australia, as we have already seen, belong to a different suborder from those of India, while there are no genera common to Australia and Africa. The monitors, all of which are included in the single genus *Varanus*, are, however, common to the three countries named, while one species actually ranges from India to Australia. That this widespread generic distribution is not a feature of the present epoch is proved by the occurrence of fossil monitors in both the two latter countries; whereas we have no evidence that they possessed genera of tortoises in common. Before proceeding further, it is well to mention that the Egyptian representative of the group is known to the natives by the name of *ouaran*, which appears to be the Arabic term for lizards in general. Transliterated as

waran, this word has been confused with the German *warnen*, to warn, whence these reptiles have been termed *warn-eidechsen*, or warning lizards; this, again, having been translated into *monitors* — a name which, however erroneous in origin, is too well established to be superseded.

The monitors are distinguished from all the lizards hitherto described by the long and deeply-forked tongue, which is capable of being protruded far in front of the lips, and is furnished at the base with a sheath, into which it can be withdrawn, as in snakes. Including the largest members of the suborder, monitors are further characterized by the long body, the broad, uncrested back, the well-developed, five-toed limbs, and the long tail, which is very frequently markedly compressed. The head is covered with small polygonal scales; the eyelids are well developed; the opening of the ear is distinct, and the head is covered with small scales. In the skull we may notice alike the absence of a bony roof over the temporal fossæ, and of teeth on the palate; while it is further remarkable for the union of the two nasal bones into a single ossification. The teeth are large and pointed, with expanded bases fixed to the sides of the jaws. On the back the scales are rounded and bordered by rings of minute granules, so that they do not overlap; in the under surface we find the squared scales arranged in crossrows. Pores are absent both on the under surface of the thigh and in front of the vent. A peculiarity of the group is the presence of an imperfect midriff, found elsewhere among reptiles alone in the crocodiles. Monitors inhabit Africa, Southern Asia, Oceania, Papua, and Australia, and are represented by nearly thirty living species, the largest of which attains a length a little short of seven feet. A fossil species from Northern India was, however, probably twelve feet long, while one from Australia could not have fallen much, if at all, short of thirty feet. The group is an isolated one, without near relationship to any other family.

The genus may be divided into four distinct sections, the first of which is represented solely by the desert monitor (*V. griseus*) of Northwestern Africa and Southwestern Asia, extending from Arabia and the Caspian to Northwestern India. This species differ from all the rest in that the nostrils are in the form of oblique slits; the tail, except sometimes near the tip, is cylindrical. Attaining a length of four feet two inches, and inhabiting the deserts of Northwestern India, and thence westward through Southern Asia to the Caspian and North Africa, it takes its name from its grayish-yellow color, which may be relieved by brown crossbars on the back and tail, and streaks of the same hue along the sides of the neck; the young always having yellow spots and dark bars. In accordance with its sombre coloration, this species is an inhabitant of sandy deserts. A far handsomer lizard than the last is the Cape monitor (*V. albigularis*) of Southern and Southeastern Africa, where it is commonly known to the Boers as the "adder." It is the first representative of the second group of the genus, in which, while the nostrils are in the form of oblique slits, the tail is compressed and keeled. Belonging to a subgroup characterized by the smooth scales of the abdomen, it is further distinguished by the absence of large (supraocular) scales above the eyes, by the nostrils being three times as far from the snout as from the eye, and by the small size of the scales. It is slightly inferior in size to the last, and has the upper parts grayish

brown, banded and spotted with yellow, and the under parts yellowish. It generally frequents cliffs, or low rocky hills, in the interstices of which it delights to hide, coming out to bask on the flat surfaces. Gray's monitor (*V. grayi*) is an example of a second subgroup in which the abdominal scales are keeled. In the third great group, of which we take as our first example the water monitor (*V. salvator*), represented in the colored plate, round or oval nostrils are accompanied



CAPE MONITOR.
(One-sixth natural size.)

by a compressed tail. In the species in question there is a series of transversely elongated scales above the eyes, the oval nostrils are situated as far from the eyes as from the tip of the snout, there are more than eighty transverse rows of scales between the fold on the throat and the groin, and the scales on the nape are not larger than those of the back. This fine species, which ranges from India through the Malayan region and China to Australia, attains a length of nearly seven feet,

and is the largest of the genus. In color it is dark brown or blackish above, with yellow rings; the snout being generally lighter, with transverse black bars, and a dark band, bordered by a yellow one, running backward from the eye, the under surface being uniformly yellow. The water monitor frequents marshy localities, being often found on trees overhanging rivers, and taking readily to the water, either fresh or salt. The last species that we notice is the well-known Nile monitor (*V. niloticus*), whose range extends all over Africa except a portion of the northwestern regions. Belonging to the same great group as the last, it represents a second subgroup distinguished by the equality in the size of the scales above the eyes; while it is distinguished from its allies by the nostrils being rather nearer the tip of the eye than the snout. In size it is somewhat larger than the desert monitor. The color of the adult is brownish or greenish gray, with darker reticulate markings, and more or less distinct yellowish eye-like spots on the back and limbs; while beneath it is yellowish, crossed by some dark bands. This species is likewise found in the neighborhood of water, generally building itself a nest among the bushes on the banks, especially of those streams that dry up in the hot season. The Papuan monitor (*V. prasinus*) of New Guinea and the islands of Torres Straits may be cited as an example of the fourth group of the genus, in which, while the nostrils are round, the tail is nearly or quite cylindrical.

Habits

As will be gathered from the foregoing, the monitors present considerable diversity of habitat, although the majority prefer the neighborhood of water. The Papuan species is, however, believed to be arboreal. All are carnivorous in their diet, feeding on frogs, snakes, the smaller mammals and birds, as well as the eggs of both birds and reptiles, especially crocodiles. Their movements are extremely rapid, both on land and in water; and many a sportsman in his first day's snipe-shooting in the rice fields around Calcutta has been startled by the sudden rush of the common Indian species (*V. bengalensis*) as it darts among the herbage close to his feet. Those species in which the tail is the most compressed are the best swimmers; this appendage serving as a powerful propeller in the water, and being also used as a weapon of offense on land. In order to enable them to remain under water for some time, the nostrils are expanded into large cavities within the snout; and when the apertures are closed these pouches serve as reservoirs of air. Writing of the great water monitor, Cantor says that it is "very numerous in hilly and marshy localities of the Malayan Peninsula. It is commonly during the day observed in the branches of trees overhanging rivers, preying upon birds and their eggs and smaller lizards, and when disturbed it throws itself from a considerable height into the water. It will courageously defend itself with teeth and claws and by strokes of the tail. The lowest castes of Hindus capture these lizards commonly by digging them out of their burrows on the banks of rivers for the sake of their flesh." Professor V. Ball gives the following account of a meeting with a lizard of the same species in the Nicobars: "As I did not care to shoot him, though I wanted to capture him, I threw stones at him, whereupon he hissed and lashed his tail in a manner that might prove alarming to anyone not knowing the harmless nature of the beast. As I was pressing him into a corner, he made a rush into the waves, but returned, apparently not liking



WATER-MONITORS ROBBING A NEST.

the surf. Just as I thought he could not escape, he made a sudden dart into the water, dived through the surf and disappeared."

From observations made on specimens in captivity, it appears that these lizards eat eggs by taking them in their mouths, raising their heads, and then breaking the shells, so that the contents are allowed to run down their throats. Although but little is ascertained regarding their breeding habits, monitors are known to lay white, soft-shelled eggs, which are deposited sometimes in the nests of white ants. As many as twenty-four eggs, of a couple of inches in length, have been taken from the body of a single female. By the Burmese these eggs are much relished as articles of food, and command a higher price in the market than hens' eggs.

THE GREAVED LIZARDS

Family *TEIIDÆ*

In America the place of the true lizards of the Old World is taken by a nearly-allied group which may be termed the greaved lizards, some of which rival the smaller monitors in size. In common with the remaining members of the suborder, these lizards are distinguished from all the foregoing by their tongues, which are slit at the tip and frequently shaped like an arrowhead, being either covered with overlapping scale-like papillæ, or marked by oblique folds. In all, the head is covered with large symmetrical shields, very different from the small scales of the monitors. They further differ by the collar bones being dilated, and often loop shaped at their inner extremities.

The greaved lizards are specially characterized by the absence of a bony roof to the temporal fossæ of the skull, and by the shields of the head being completely free from the underlying bones; there are no bony plates on the body. On the body and tail the scales are arranged in transverse rows. The teeth, although very variable, differ from those of the true lizards of the Old World in not being hollow at the base; the replacing teeth being developed in small sockets at the roots of those in use. In some cases these teeth, which may be either pointed or of a flattened crushing type, are placed near the summits of the jaws, and in others somewhat on the side, so that the dentition is intermediate between the typical acrodont and pleurodont modifications; the front teeth are always conical. On the palate teeth are but seldom present, and, if developed, are small. The long tongue, which is frequently retractile within a sheath, is generally covered with overlapping scales; the drum of the ear is exposed, and the eyes are generally furnished with lids. The majority of the forms resemble the true lizards in general appearance, although in some the number of toes is reduced to four. In others, however, the limbs take the form of mere stumps, while the hind pair may be wanting, in which case there is a near approach to the amphisbænas.

The greaved lizards comprise over a hundred species, arranged in thirty-five genera, which are distributed over the warmer parts of America, although most

numerous in the equatorial regions. Various in their habitat, some frequent dry, sandy plains, others dwell among the herbage of meadows, while others prefer woods, and a few are partially or wholly subterranean; these latter either taking possession of some empty hole, or digging one for themselves. In their general mode of life they resemble the monitors and true lizards, although some are more

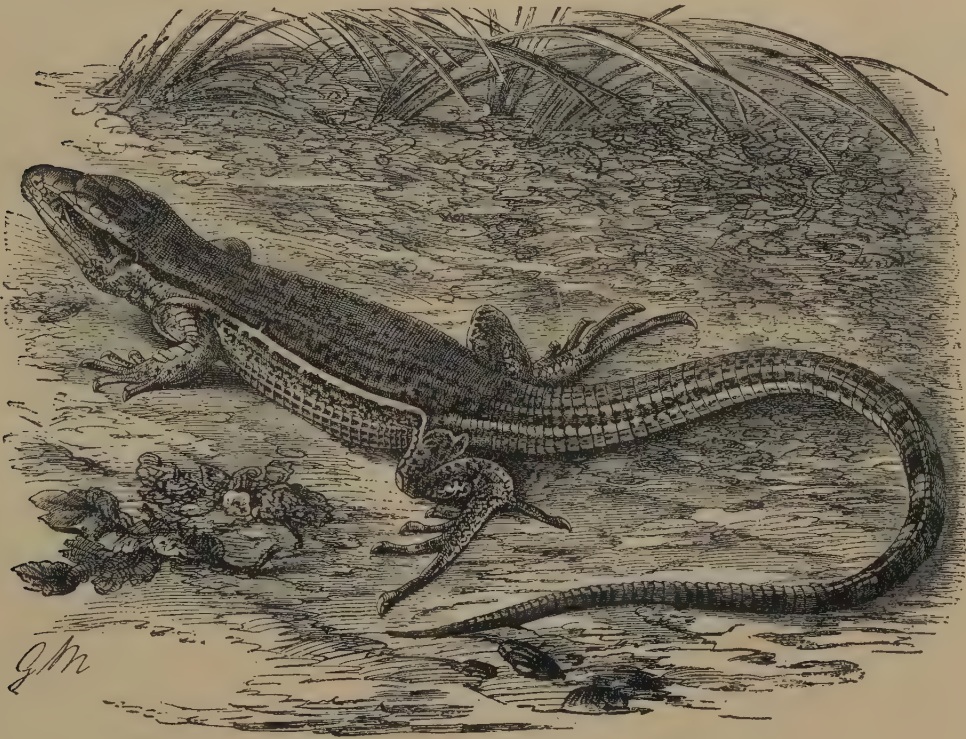


THE TEJU.
(One-fourth natural size.)

like the amphisbænas. They are generally swift and active in their movements; and the larger kinds are thoroughly carnivorous, subsisting not only on insects, worms, slugs, and snails, but likewise hunting such of the smaller vertebrates as they are able to overcome. Most species deposit their eggs in the hollow stems, or among the roots of trees. A few of the larger species are hunted for the sake of their flesh, which is stated to be tender and well flavored.

The Teju

One of the largest and best-known representatives of the family is the lizard variously termed the teju, teguexin, or jacuaru (*Tupinambis teguexin*), which ranges over a large portion of South America and the West Indies, and belongs to a genus comprising three species. These lizards may be recognized by the tail being round at the root and slightly compressed near the middle, the double fold of skin on the neck, the uniform scales of the back, the rather small squared shields of the under surface of the body, which are arranged in more than twenty rows, the want of teeth on the palate, the compressed tricuspid cheek teeth of the young, and the long tongue, which is of nearly equal width



SURINAM AMEIVA.
(One-half natural size.)

throughout, and sheathed at the base. In old individuals the crowns of the cheek teeth become obtuse. The teju, which attains a length of about a yard, is a bulky and strikingly-colored lizard. Above, the ground color is olive, upon which are markings and bands of black, and more or less distinct rows of lighter spots; while the under surface is yellowish, with interrupted black bars; the lines of division between the shields of the head being black.

Ranging from Guiana to Uruguay, the teju is said by Bates to be very common in the forests of the Amazon, where it may be observed in numbers during the mid-day stillness scampering, apparently in sport, over the dead leaves; while in other

districts it haunts sugar plantations. Although frequently found in the neighborhood of water, it apparently never enters it; and generally dwells in wide-mouthed holes situated beneath the roots of trees. Shy and retiring to a degree in inhabited districts, when driven into a corner it shows fight, hissing at and striking with its muscular tail the dogs employed in its pursuit. When sitting, the head is generally raised and the forked tongue is in constant motion. Its diet comprises such living creatures as it can capture, together with eggs. The female lays from fifty to sixty hard-shelled eggs about the size of those of a pigeon, generally placed in the hillocks of white ants.

The *dracæna* (*Dracæna guianensis*) of the Guianas and Amazonia is a somewhat smaller lizard, distinguished by its compressed and doubly-keeled tail, the intermixture of keeled tubercles among the scales of the back, and the extremely-broad crowns of the cheek teeth.

Our second figured representative of the family is the Surinam The Ameivas ameiva (*Ameiva surinamensis*), belonging to a genus of nearly twenty species distributed over Central and South America, where they take the place occupied by the true lizards in the Old World. They are distinguished by their round keelless tails, the presence of less than twenty rows of large smooth scales on the under surface of the body, and the compressed two- or three-cusped cheek teeth. The tongue can be withdrawn into a sheath. The figured species, which is found over South America as far as Nicaragua, attains a length of from fifteen to twenty inches, and is very variable in coloration. The young are olive brown, with darker markings or white dots, and a black, white-edged band running along the side of the body and extending on to the tail; these bands generally disappearing with age, although sometimes retained in the females. In the adult the upper surface is usually greenish, with some black and a few white spots; the under parts are greenish white, spotted with black on the sides. Ameivas are generally found in dry districts—more especially near the coasts, and in their general habits are not very different from the teju, usually living in holes, among old wood, or the herbage of gardens.

THE AMPHISBÆNAS

Family AMPHISBÆNIDÆ

Among the most remarkable of all lizards are those whose typical representatives have the power of moving equally well either backward or forward, from whence they derive the name by which the group is now commonly designated. Very nearly related to the preceding family, through those members of the latter with aborted limbs, the amphisbænas are distinguished by the simple and degraded characteristics of the skull, in which all the arches have been lost, and the two pre-maxillary bones are fused into one. All are adapted to a purely subterranean existence, and have long, worm-like bodies, devoid, except in one species, of any external trace of limbs; while even the bones of the shoulder and pelvis are more or

less rudimental. The eyes are concealed beneath the skin; the mouth is small, and frequently inferior in position, and the ear is completely wanting. Although the head is covered with large symmetrical shields, the skin of the body is divided into squared segments forming regular rings, like those of worms; from which characteristic the group is sometimes spoken of as the ringed lizards. In all the tail is short. The large teeth are few in number, and fixed either to the inner or upper edges of the jaws.

The amphisbænas, which are arranged in eleven genera, including between sixty and seventy species, are most numerous represented in America south of the Tropic of Cancer, although also occurring in the West Indies, while Africa possesses over twenty species, and four are found in the Mediterranean area. Of



HANDED AMPHISBÆNA.
(Natural size.)

their habits, Mr. Boulenger observes that all the members of this family are burrowers, and may live in ants' nests. They bore narrow galleries in the earth, in which they are able to progress backward as well as forward. On the ground they progress in a straight line by slight vertical undulations, not by lateral movements, as in other limbless reptiles; and the tail of many species appears to be more or less prehensile. The food of these lizards consists of small insects and worms. As regards their breeding habits, it is only known that one species lays eggs, which are deposited in ants' nests. The marked resemblance of these lizards to earth worms is a most curious instance of the similarity produced in the external form of different groups of animals by adaptation to similar modes of life; the remarkable feature in this case being the occurrence of this resemblance in creatures so widely

sundered from one another, as are worms and amphisbænas. Fossil members of the family have been discovered in the Tertiary rocks of North America.

Handed

**Amphis-
bæna**

The one member of the family which exhibits evidence of its relationship to less specialized lizards in the retention of rudimentary fore-limbs is the handed amphisbæna (*Chirotus caniculatus*) of Mexico and California; this being one of the two species found on the continent of America to the north of the Tropic of Cancer. This creature, which attains a length of about seven inches, and is of a brownish flesh color, is distinguished by the presence of a pair of small depressed fore-limbs, placed close to the head, to which they are about equal in length; each of these being provided with four well-developed and clawed toes, of which the outermost is the shortest.



SPOTTED AMPHISBÆNA.
(Two-fifths natural size.)

Typical

**Amphis-
bænas**

The typical members of the family constitute a genus (*Amphisbæna*) common to tropical America and Africa, and represented by nearly thirty species. Belonging, like the last genus, to the group in which the teeth are attached to the inner edges of the jaws, these limbless amphisbænas are specially characterized by the anterior body rings not being enlarged, by the laterally placed nostrils being pierced in a special nasal shield, by the rounded or slightly compressed snout, the obtuse, cylindrical tail, and the presence of pores in front of the vent. The figured species (*A. fuliginosa*) is a well-known kind from tropical America and the West Indies, deriving its name from its pied skin, and attaining a length of about eighteen inches. Writing of the habits of a member of the genus, Bates observes that their "peculiar form, added to their habit of wriggling backward as well as forward, has given rise to the fable that they have two heads, one at each extremity. They are extremely sluggish in their motions, and live habitually in the subterranean chambers of the sauba ant; only coming out of their abodes occasionally in the nighttime. The natives call the amphisbæna the *mai das saubas*, or mother of the saubas, and believe it to be poisonous, although it is perfectly harmless. It is one of the many curious animals which have become the subject of mythical stories with the natives. They say the ants treat it

with great affection, and that if the snake be taken away from a nest the saubas will forsake the spot. I once took one quite whole out of the body of a young jararaca [a poisonous snake], whose body was so distended with its contents that the skin was stretched out to a film over the contained amphisbæna. I was, unfortunately, not able to ascertain the exact relation which subsists between these curious reptiles and the sauba ants. I believe, however, that they feed upon the saubas, for I once found the remains of ants in the stomach of one of them."

THE TRUE LIZARDS

Family *LACERTIDÆ*

The true lizards, constituting the typical representatives of the suborder, form a large family, with seventeen genera, distributed over Europe, Asia, and Africa (exclusive of Madagascar), but most abundant in Africa, and comparatively rare in the Oriental countries. Taking the place in the Old World occupied in the New by the greaved lizards, these reptiles are readily distinguished from the latter by the temporal fossa of the skull being roofed over with bone as shown in the figure of the skeleton on p. 2466, and likewise by the shields of the head being firmly attached to the underlying bones, as well as by the union of the two premaxillary bones, the latter feature being common to this family and the amphisbænas. All of them have well-developed limbs, each furnished with five toes, the body plump and separated by a well-marked neck from the head, the tail long and brittle, the drum of the ear exposed, and the eyelids distinct and generally freely mobile. The skin contains no bony plates; the scales of the back are either overlapping or in apposition; while those of the under surface are generally larger, and arranged in longitudinal and transverse rows. The teeth are always attached to the sides of the edges of the jaws (pleurodont), and differ from those of the grooved lizards in their hollow bases; those of the cheek series having two- or three-cusped crowns. The flat and scaled tongue is of considerable length and cleft both in front and behind, so as to assume the form of an arrowhead. As a rule, pores are present on the hinder surface of the thigh.

Out of about one hundred species of true lizards, two are found in the British Islands, where, with the exception of the blindworm, they are the only representatives of the suborder; but many others inhabit Southern Europe. Lizards of this family are veritably creatures of the sun, delighting to bask in its rays on some warm sandy bank, wall, or rock, and retiring to their holes and crannies in cloudy or rainy weather. The more powerful and bright the sun, the more active, indeed, do these reptiles become, since most of them are dull and listless in the morning and evening, and only wake to full activity in the midday glare. Over the greater part of Europe they spend a large portion of their time in their holes, and with the commencement of October retire for their winter sleep, from which they do not awake till spring is well advanced. Comparatively rare in Northern Europe, in the south of the continent lizards are common enough to form an

attractive feature in the landscape, their burnished metallic-green and bronzy scales flashing in the sunlight on every wall, and in every road and path. The darting movements of these pretty reptiles, as they are in pursuit of the flies and other small insects which constitute their chief prey, are familiar to all. While the majority lay eggs, the viviparous lizard produces living young.

Pearly Lizard The pearly lizard (*Lacerta ocellata*) of Southern Europe, which is also represented by a variety in Algeria, may be taken as our first example of the typical genus *Lacerta*, of which there are over twenty species, inhabiting Europe, North and West Asia, Africa north of the Sahara, and the Atlantic islands. The members of this group, which may be collectively designated collared lizards, are distinguished by the following features: The body is cylindrical or slightly depressed; the head pyramidal with upright sides; the neck not very well defined, and the tail cylindrical, tapering, and long. The throat is furnished with a well-marked collar of enlarged scales; the scales on the back are smaller than those on the tail, and are at most but slightly overlapping; the shields of the under surface are squared, and slightly overlapping. The rounded or compressed toes have either smooth, tuberculated, or indistinctly-keeled pads on the lower surface, while the thighs have pores. In common with several other genera, the nostrils are placed close to the so-called labial scales, from which they are separated at most by a narrow rim; and if there be a transparent disc in the lower eyelid, it is smaller than the eye. Among the most beautifully-colored members of the sub-order the pearly lizard, which attains a length of from sixteen to twenty-three inches, claims a foremost place. Belonging to a large group of the genus, in which the edge of the throat collar is strongly serrated, this species agrees with certain other members of the genus in its smooth tail, and in the scales on the sides of the body not being smaller than those on the back. As special characteristics of the species, it may be noted that the scales are smaller than in the allied forms, and that there are not less than seventy scales round the middle of the body, eight or ten of which belong to the under surface. The head is very large in the male, and characterized by the great width of its hindmost, or occipital, median shield. In color, the upper parts are either green, with black dots or network, or blackish olive with yellowish netting; the sides are marked with a row of about a dozen eye-like blue spots; while the under surface is uniform greenish yellow. The olive-colored young are, however, dotted all over with white, or pearly-blue, black-edged spots.

Common in Spain, and also occurring in the south of France and Northwestern Italy, or wherever the olive tree grows, the pearly lizard is generally to be met with in the neighborhood of hollow trees, frequently ascending some distance up their trunks, or even climbing among the branches. The males are somewhat quarrelsome, and the females lay from six to ten eggs, generally deposited in a hollow olive tree.

Green Lizard Another well-known European species is the green lizard (*L. viridis*), attaining a length of about twelve inches in Germany, but in the more southern portions of its habitat measuring as much as seventeen inches; fully two-thirds of this length being occupied by the long tail. Having not more than

sixty-six scales round the middle of the body, this lizard is distinguished by the general presence of two small superimposed scales behind each nostril, the small size and triangular form of the occipital shield, and the arrangement of the abdominal scales in six longitudinal rows, the collar being serrated. Usually the nostrils are in contact with the front or rostral shield of the head, and in the female and young the foot is longer than the head. As regards color, the males, which may be distinguished from the females by the larger and higher head, the thickened root of the tail, stouter hind-limbs, and generally superior size, are some shade of green olive, passing below into yellow. Black dots, passing into large spots, gen-



GREEN LIZARDS.
(Two-thirds natural size.)

erally adorn the upper surface, whereas the under parts, save for a blue patch on the chin and throat, are uniform. The females, in which the blue on the throat is less constantly present, have a more brownish tinge, with the sides ornamented with black-bordered yellowish spots. The young are generally leather brown in color, with one or two yellow side stripes. Both sexes vary, however, considerably according to age; and southern specimens are more brilliantly colored than those from the north.

The green lizard is an inhabitant of the countries lying to the east and north of the Mediterranean, and thence extending eastward to Persia. Very common in

Portugal and Spain, where it is represented by a variety, it extends in France as far north as Paris, but it is unknown in Sardinia. In place of resorting, like the pearly lizard, to trees, this species is usually found on the ground, more especially in districts where the subsoil is rocky, ranging from the sea level to a height of some three thousand feet, and being equally at home on the plains or among the mountains, in stony or sandy districts, on bare rocks, or among thick bush. As rapid as lightning in its movements, it feeds chiefly upon large insects and their larvæ, together with slugs and worms; living in grassy districts almost entirely upon grasshoppers, and at times attacking smaller species of its own tribe. In Switzerland and Germany the female usually deposits her eight to eleven white eggs during June, these being hatched in the course of a month or so; and it is generally during the breeding season that the blue on the throat is assumed by this sex.

The third European representative of the genus is the much smaller Sand Lizard sand, or hedge lizard (*L. agilis*), which is a more northern form, ranging into the British Islands and Scandinavia. Usually not more than eight inches in length, although occasionally measuring nearly ten, this lizard may be recognized by its short, thick, and blunt-snouted head, and by the tail being considerably less than twice the length of the head and body. Never having more than fifty-eight scales round the middle of the body, it is further distinguished by the rostral shield of the head being separated by a small interval from the nostrils, by the trapezoidal shape of the small occipital shield, by the absence of the row of small granules which occur between the shields of the eyelids (supraoculars) and eyebrows (supraciliaries) in the green and wall lizards, and by the foot being not longer than the head. Although there is great variation in this respect, the general color of the male is greenish, and that of the female gray or brown; the crown of the head, a streak down the back, and the tail being mostly brown, while the chin and under parts are greenish or yellowish. The streak down the back, and in the females also the sides, are marked by rows of white spots, which are sometimes large and eye-like; and the under surface is marked with black. Some individuals, especially males, closely approach the green lizard in coloration.

The range of the sand lizard embraces North, Central, and Eastern Europe, and extends eastward to Western Siberia and Asiatic Russia. In England it is generally found on sandy heaths, where it may often be seen running across the open paths with a speed less rapid than that of the more common viviparous species. It is more timid and less easily tamed than the green lizard, generally pining and refusing to feed in captivity. According to Bell, the female lays her eggs, to the number of twelve or fourteen, in hollows in the sand, which she excavates for the purpose, and having covered them carefully with sand, she leaves them to be hatched by the solar heat.

A still smaller, and at the same time a more slightly-built species Viviparous Lizard is the common English viviparous lizard (*L. vivipara*), which varies in length from six to just over seven inches in length. It has larger scales than the last, which are not more than forty-five round the middle of the body, and the foot generally exceeds the head in length; granules being absent



WALL - LIZARDS.

above the eyes. The absence of teeth on the palate is another feature in which this species differs from the sand lizard. The color of the adult is brown, yellowish, or reddish, ornamented with small dark and light spots, and often with a dark streak down the back, and another, edged with yellowish, on each side. In the male, the under surface is orange or vermillion, spotted with black, and in the female, pale orange or yellow, sparsely spotted with black, or uniform. The young are nearly black, and this hue occasionally persists. Unknown to the south of the Alps, the viviparous, or, as it is sometimes called, mountain lizard, is spread over the greater part of North and Central Europe, and the whole of Northern Asia, as far as Amur-



VIVIPAROUS LIZARD
(Natural size.)

land, ranging in the Alps to a height of nearly ten thousand feet. At this elevation it is, however, dormant for fully three-quarters of the year, being active for only two or three months. In Britain it extends to Scotland, and is one of the few reptiles found in Ireland. Generally similar in its habits to its allies, it is more fond of water, and is a good swimmer, usually frequenting heaths and banks. "Its movements," writes Bell, "are beautifully graceful as well as rapid; it comes out of its hiding place during the warm parts of the day from the early spring till autumn has far advanced, basking in the sun, and turning its head with a sudden motion, if an insect come within its view, and, darting like lightning upon its prey, it

seizes it with its little sharp teeth, and speedily swallows it." Unlike its kin, this species produces living young, varying from three to six in number, which are active as soon as born, and remain in the company of their parent for some time.

The last representative of the typical genus that we shall notice is the beautiful wall lizard (*L. muralis*), of which a group is depicted in our colored plate. This southern species, which inhabits the countries bordering both sides of the Mediterranean, and extends eastward into Persia, belongs to a group in which the edge of the collar on the neck is even or but slightly serrated, and the scales of the back are granular. Attaining in Germany a length of from seven to seven and one-half inches, but reaching from eight to nine and one-half inches in Italy, this species has a series of granules between the shields above the eyes, while the scales of the abdomen are arranged in six (rarely eight) rows, and those on the upper surface of the leg are larger than those on the back, and there is but a single (postnasal) scale behind each nostril. In color the wall lizard presents such an astonishing variation, that it is almost impossible to give any general description. In German examples the ground color of the back is, however, often brown or gray, with bronze-green reflections in sunlight, upon which are blackish streaks, marblings, and spots; while the flanks have a row of blue spots, and the under parts vary from milk white to copper red, frequently variegated by spots or marblings. In Southern Europe these lizards may be seen basking on almost every wall, old building, or face of rock, where they delight all beholders with their activity and tameness. "Scarcely two," writes Leith-Adams, "are marked alike; the brightness and variety of their hues are most beautiful and attractive, and, like the chameleon, they change color with the coruscations of sunshine, but, of course, not to the same extent. During an excursion to the islet of Filfla, on the southern coast of Malta, in the month of June, I was surprised to find that all the lizards on the rock were of a beautiful bronze black, and so much tamer than their agile brethren on the mainland. Many individuals were so tame that they scrambled about our feet, and fed on the refuse of our luncheon." Whereas in the Southern Tyrol these lizards remain active till December, and reappear by the middle of February; in Germany their winter sleep is considerably longer. Like its congeners, this species has an exceedingly-brittle tail; and it was observed some years that on a certain road in Madeira all the lizards belonging to a nearly-allied species (*L. dugesi*) were without tails. The circumstance was explained by the spot being the favorite resort of the midshipmen landing from the ships visiting the island, who amused themselves by knocking off the lizards' tails.

The members of the genus *Lacerta*, as we have seen, are characterized by the presence of a well-marked collar on the neck, by the scales of the back being smaller than those on the tail, and by the toes being without fringes on their sides, or keels on their soles. An allied genus—*Agiloides*—represented by three species from the eastern coast of the Adriatic, Greece, Sardinia, and Corsica,—differs by the strongly overlapping scales of the back being nearly as large as those of the tail. On the other hand, four species inhabiting Southwestern Europe and the opposite coast of Africa constitute a third genus—*Psammodromus*—in which the collar is indistinct or wanting, the toes are

not fringed, though generally more or less distinctly keeled inferiorly, while the overlapping scales of the back bear strong keels. Among these the Spanish keeled lizard, or sand runner (*P. hispanicus*), retains a trace of a collar and has strongly-keeled soles; whereas in the Algerian keeled lizard (*P. algirus*) the collar is wanting, and the soles are at most but feebly keeled. The figured species, which inhabits not only Northwestern Africa, but likewise Portugal, Spain, and the south



ALGERIAN KEELED LIZARDS.
(Three-fourths natural size.)

of France, reaches nearly ten and one-half inches in length, and has a tail almost twice as long as the head and body. It is specially distinguished by the scales of the abdomen being of nearly equal width and arranged in six rows, as well as by the presence of from thirty to thirty-six scales round the middle of the body. In color, this lizard is bronzy green above, with one or two golden, dark-edged streaks along the side; the male being ornamented with a pale blue eye-like spot

above the shoulder, sometimes followed by one or two behind, while the under parts are whitish. Abundant in Algeria and the neighborhood of Montpellier this lizard is found in the former region both in hedges and on limestone rocks, whereas in France it frequents hedges alone. Preferring dry, open, and warm districts, and thriving well in captivity, it presents nothing specially noteworthy as regards its habits.

Fringe-Toed
Lizards

The fringe-toed lizards (*Acanthodactylus*), of which there are ten species ranging from Southern Spain and Portugal, and Northern Africa through Southwestern Asia to the Punjab, differ from the preceding group by the toes being both fringed on the sides and keeled below; a more



COMMON FRINGE-TOED LIZARDS.
(Natural size.)

or less distinct collar occurring on the throat. On the head, the occipital shield is wanting, and the nostrils are pierced between one labial and two nasal shields. Pores are present on the thigh, and the tail is nearly cylindrical. The common fringe-toed lizard (*A. vulgaris*) is a species of from four and one-half to four and three-fourths inches in length, agreeing with most of its kindred in having the hinder scales of the back but little enlarged, and specially characterized by the strong keeling of the scales on the upper surface of the tail, and the slight pectination of the toes. It is represented by two varieties, one occurring in Spain and Portugal, and rarely in the south of France, characterized by the smooth or slightly-keeled scales of the back, and an African form in which these scales are very strongly

keeled, and the coloration is brighter. The color of the adult is grayish or brownish, with faint longitudinal series of light and dark spots and lines, and sometimes eye-like blue spots on the flanks; the young being longitudinally streaked with black and white, and having white spots on the limbs. All these lizards inhabit dry sandy districts, and are remarkably shy in their habits, seldom venturing forth from their retreats except when the sun is shining brightly.

THE SKINK TRIBE

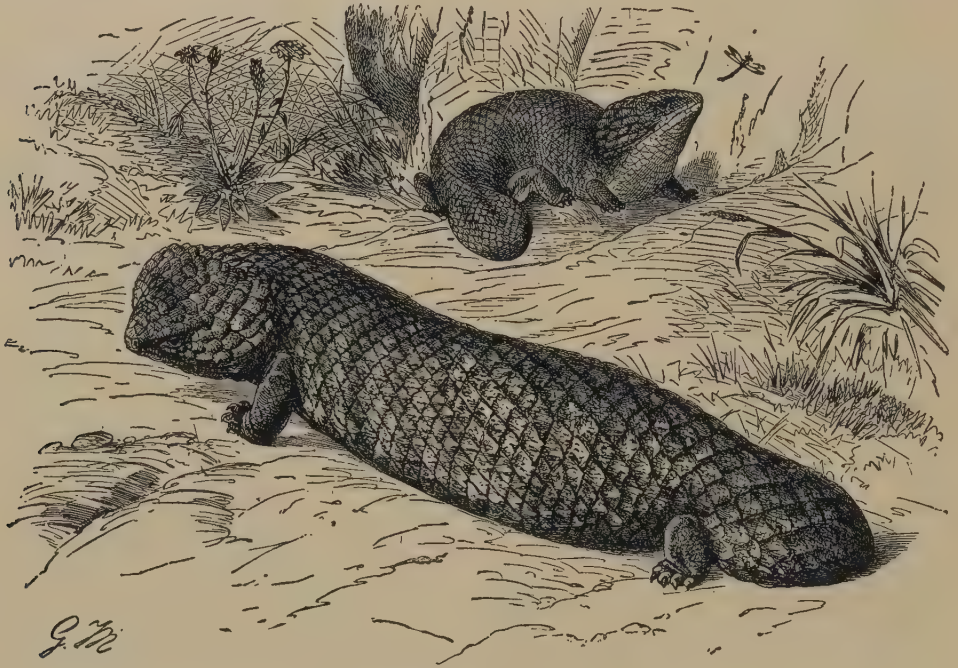
Family *SCINCIDÆ*

The preceding family is connected with the one we have now to consider by a small group of five African genera constituting the family *Gerrhosauridæ*, which, while resembling the true lizards in having but a single premaxillary bone and the presence of pores on the thigh, agree with the skinks in possessing bony plates of peculiar structure beneath the scales. The skink tribe, taking their title from the lizard commonly known by that name, are a very numerous family, comprising upward of twenty-five genera and nearly four hundred species, and presenting great variety of bodily form, some kinds being four limbed, while others are more or less completely snake-like. Agreeing with the true lizards in the characteristics of the tongue and teeth, as well as in the roofing over of the temporal fossæ by bone, the skinks differ in having two distinct premaxillary bones in the skull, in the presence of bony plates traversed by symmetrical tubules beneath the scales, and in the invariable absence of the pores which are generally present in the thighs of the *Lacertidæ*. The limbs, when present, are relatively short, and in some cases are reduced to two, and in others absent; the number of toes is very variable, even among the members of a single genus; the short and scaly tongue is free, and but slightly notched in front, and the drum of the ear is generally covered with scales. The eyes have round pupils, and well-developed and generally mobile lids, the lower one of which has a large transparent window. The teeth, which are attached to the sides of the jaws, may have either conical, bicuspid, or broad and spheroidal crowns (*Tiliqua*). The head is covered by large symmetrical shields, among which an unpaired occipital is generally wanting; and the overlapping scales of the body are generally subhexagonal in form and arranged in a quincuncial manner. World-wide in distribution, the skink tribe are most numerous represented in Australia, Oceania, the Oriental region, and Africa, while very few occur in South America, and there are not many in North America and Europe. Although their habits are not fully known, it appears that, with the exception of two genera, they bring forth living young, varying from two to ten in number. The majority are terrestrial, a few only being able to climb, while none are aquatic. They sedulously avoid the neighborhood of water, frequenting dry situations, and more especially those where the soil is sandy with an admixture of pebbles or fragments of rock. Moreover, they generally possess the faculty—rare among lizards—of burrowing in the ground with the dexterity, if not with the power, of moles. From this habit the

group is sometimes spoken of as the burrowing lizards; and it may be remarked that their spindle-shaped bodies, covered with highly-polished scales, their short legs, and frequently abbreviated tail, as well as the transparent window in the lower eyelid, are all features specially adapted for such a mode of life. From among the numerous genera, the limits of our space render it necessary to confine our remarks to four, which are selected as examples of very divergent types.

Described as far back as the year 1699, the stump-tailed lizard (*Trachysaurus rugosus*) of Australia is the sole representative of one of the most remarkable genera in the entire suborder. With a short, pyramidal depressed head of great width, a short but distinct neck, a long, thick,

Stump-Tailed
Lizard

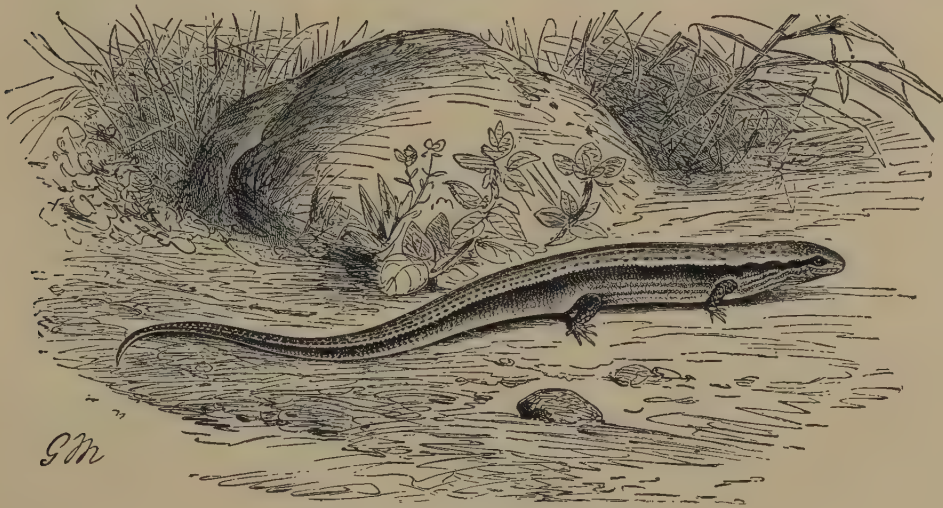


STUMP-TAILED LIZARDS.
(One-third natural size.)

and flattened body, and a very wide and stumpy tail, the creature is clothed with an armor of rough, thick, brown scales, which give it very much the appearance of a living pine cone. On the lower surface, the scales are smooth and much smaller. The small and stout limbs are widely separated, and terminate in five short toes, each provided with strong curved claws. In length this strange reptile measures about fourteen inches, and its color above is brown with spots or irregular bands of yellow, while beneath it is yellowish, with brown spots, marblings, or longitudinal and transverse streaks. The cheek teeth have subconical crowns. Beyond the fact that it is a burrower, scarcely anything appears to be known of the habits of the stump-tailed lizard in a wild state, although many observations have been made on captive specimens. In the latter state it is slow and lethargic in its

movements, creeping about with the abdomen pressed to the ground. Its chief food consists of worms and insects, although fruit and vegetables are occasionally eaten; and that it can endure long fasts is proved by an example which only ate two or three flies during the voyage from Australia to England.

Very different in appearance to the last is the lizard (*Ablepharus* *Snake-Eyed* *Lizards* *pannonicus*) represented in the accompanying illustration, which belongs to a genus containing a number of small species distributed over Australia, Southwestern Asia, Southeastern Europe, and tropical and South America, one of which (*A. boutonii*) ranges irregularly over the hotter parts of both the Eastern and Western Hemispheres. These lizards differ from all their kin in having no movable eyelids, their place being taken by a transparent disc of skin stretched over the eye after the manner of snakes. In this genus the ear may be either open or concealed by scales; and while some of the species have well-developed



EUROPEAN SNAKE-EYED LIZARD.
(Natural size.)

limbs, in others they are more or less aborted, the number of toes being also highly variable. The figured species, which ranges in Europe from Hungary to Greece, and is also spread over Asia Minor, Syria, and Northern Arabia, measures only four inches in length, of which fully half is occupied by the tail. Its general color above is bronzy olive, becoming darker on the sides, and with a blackish light-edged streak passing through the eye along each side of the body; the under parts are greenish. The European species is found alike on slopes covered with short grass or in sandy spots, and does not appear to be a burrower. Feeding on small insects and worms, it does not generally venture forth from its lurking places till four or five o'clock in the afternoon, and retires before night. In common with the other members of its genus, it differs from the majority of its family in laying eggs.

True Skinks While both the genera mentioned belong to a group characterized by the palatine bones meeting in the middle of the palate, the true skinks indicate a second and smaller group in which those bones are separated from one another. Skinks are neatly made, somewhat short-tailed lizards, with short limbs provided with five toes serrated on their sides. The tail is conical, the head and snout wedged shaped, the ear more or less concealed; while the nostrils are pierced between an upper and a lower nasal shield. Of the nine species of the genus, which range from North Africa through Arabia and Persia to Sind, the most familiar is the common skink (*Scincus officinalis*) of the Sahara and Red Sea littoral. This species, which attains a length of eight and one-fourth inches, has smooth, shining, rounded scales of great breadth, and is of a yellowish or brownish

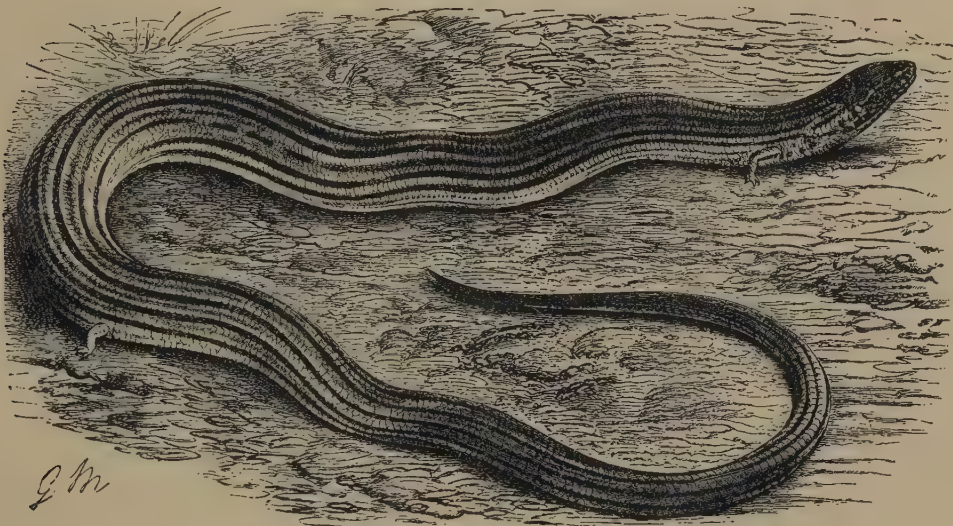


COMMON SKINK.
(Two-thirds natural size.)

color above, with each scale marked by small brown and whitish spots and streaks, and the sides of the body often ornamented with dark transverse bands; the under parts being uniformly whitish. Not uncommon in Egypt, and abundant in the Algerian and Tunisian Sahara, the common skink derives its specific name from having been extensively employed in medicine as an infallible remedy for almost every disease under the sun; its reputation as a healing agent still surviving among the Arabs, by whom the flesh of the creature is used both as a drug and as an article of food. The exclusive haunts of the skink are sandy districts, where it generally moves in a slow and deliberate manner, and when frightened buries itself in the soil instead of attempting to seek safety in flight. Indeed, the celerity with which the reptile sinks into the sand is described as being little short of marvelous, suggesting the idea of its escaping into some hole already

existing rather than of excavating a fresh burrow for itself, such a burrow not unfrequently extending to the depth of several feet. During the daytime the skink, if quietly approached, may be observed quietly reposing in the sun by the side of one of the small hillocks or ridges raised in the sand at the base of trees by the wind; and from such a state of idleness it is only roused by the approach of a beetle or a fly, upon which it darts with unerring aim. In spite of its strong teeth or claws, when captured, the skink never makes any attempts to defend itself, beyond struggling vigorously. Of its breeding habits, little or nothing definite appears to be known. According to Canon Tristram, the flesh of a few well-broiled skinks forms a dish not to be despised even by a European palate.

Under the title of *Chalkis*, the ancient Greeks designated a remarkable snake-like lizard inhabiting Italy, Sardinia, and Sicily, as well as Algeria and Tunis, which was known to the Romans by the name of *Seps*;



THREE-TOED BRONZE LIZARD.
(Natural size.)

the latter being in allusion to the poisonous properties with which this perfectly harmless reptile was supposed to be endowed. The "seps" (*Chalcides tridactylus*) is the typical representative of a genus of some twelve species belonging to the present family, which exhibit a most interesting example of the gradual degradation of limbs, some species having five toes to each foot, while in others, as the figured example, the number of digits is reduced to three, and in one kind the limbs are represented merely by undivided rudiments. The bronze lizards, as the members of the genus may be collectively termed, belong to an assemblage of genera differing from all those already noticed in that the nostrils are pierced either in or close to the terminal rostral shield of the skull, instead of being more or less widely separated therefrom. In the case of the present genus the nostrils are situated in

notches cut in the hinder border of the shield in question; while the body is greatly elongated, and the limbs are either short or rudimental. The figured kind is one of two species with three-toed limbs, and attains a length of thirteen and one-half inches, of which about half is occupied by the tail. In color it is olive or bronzy above, and may be either uniform, or marked with an even number of darker and lighter longitudinal streaks. In the south of France, Spain, and Portugal, it is replaced by the smaller striped bronze lizard (*C. lineatus*), in which the body is marked with nine or eleven longitudinal stripes. The range of the whole genus embraces Southern Europe, Northern Africa, and Southwestern Asia, from Syria and Arabia to Sind.

The three-toed bronze lizard much resembles the blindworm in general appearance and habits, frequenting damp places where abundance of its favorite worms, snails, slugs, insects, and spiders are to be met with. Here it moves with a wriggling serpentine motion similar to that of the blindworm, which it likewise resembles in producing living young and in retiring into a burrow for its winter sleep. When not feeding, the creature, like most of its kind, delights to bask on sandy spots in the full glare of the sun. The "seps" was believed to inflict death on cattle by biting them during the night, its bite filling their veins with corruption; and in consequence of this belief the unfortunate creature is still persecuted with the same hatred as is the blindworm in some parts of England.

The two remaining families (*Anelytropidæ* and *Dibamidæ*) are represented by worm-like burrowing lizards allied to the skinks (of which they may be regarded as degraded types), but with no bony plates beneath the scales, no external ear openings, and eyes concealed beneath the skin. The former family is represented by three genera, of which two are African, and the third is from Mexico; while of the latter there is but a single genus, with one species from Papua, the Moluccas and Celebes, and a second from the Nicobars.

THE CHAMÆLEONS

SUBORDER Rhiptoglossa

With the skinks and their allies we took leave of the last of the reptiles which, in the zoological sense, are included under the title of lizards, and we now come to a second subordinal group, represented by those strange creatures known as chamæleons. From the lizards proper these reptiles are at once distinguished by their worm-like extensile tongues, which are club shaped and viscous at the extremity, and are capable of being protruded with the rapidity of lightning to a distance of from four to six inches in front of the mouth. Hence the name of worm-tongued lizards has been suggested for the group. Internally, the chamæleons differ from all lizards provided with well-developed limbs in having no collar bones (clavicles); while there are likewise certain distinctive features in connection with the skull, into the consideration of which it will be unnecessary to enter in this work. An-



CHAMÆLEONS.

other important feature by which these reptiles differ from lizards is the structure of the feet, in which the toes are divided into two opposing branches, thus forming grasping organs of great power. In the fore-foot the inner branch of the foot includes three, and the outer two toes, in the hind-foot precisely the reverse arrangement obtains; and from this peculiar hand-like structure of the foot,—which, by the way, recalls the feet of the parrots and many Picarian birds,—the chamæleons have been spoken of as four-handed lizards. Yet another peculiarity in the structure of these reptiles is presented by the eye, which is in the form of a very large and prominent globe covered by a thick granular lid, in the centre of which is a minute perforation for the pupil. The deliberate way in which a chamæleon rolls round one of these extraordinary eyes until it has focused it on the fly about to be caught by the tongue is familiar to most of our readers.

The foregoing are the essential features by which the chamæleons are distinguished from the lizards proper; those remaining for mention not being such as would be regarded by zoologists as of subordinal importance. Among these may be noticed the triangular helmet-like form generally assumed by the hinder part of the head, which often has three longitudinal ridges, connected posteriorly by a cross ridge, all of which are ornamented with tubercles. The teeth, which are small, triangular, and compressed, are placed on the summits of the jaws in the acrodont fashion, none being present on the palate. The body is much compressed, and the neck short; the slender limbs are so much elongated as to raise the body high above the ground in a manner different from ordinary lizards; the tail is long and prehensile, thus acting as a fifth hand; and in place of scales, the head and body are covered with tubercles or shagreen-like granules. The larger species attain a length of some fifteen inches; but the dwarf chamæleon of Madagascar (*Brookesia nanus*) is less than two and one-half inches in length.

The chamæleons include close on fifty species, all of which are comprised in the single family *Chamæleontidæ*, and by far the greater majority in the typical genus *Chamæleon*. Indeed, of the two aberrant genera, *Brookesia* is represented by three species from Madagascar, while *Rhampholeon* comprises two tropical African kinds. The true home of the group is Africa and Madagascar, together with the neighboring islands, each of these areas comprising nearly half of the known species. The common chamæleon (*C. vulgaris*) is, however, found on the African and Asiatic coasts of the Mediterranean, entering Europe in Andalusia; while a second species inhabits the isle of Socotra, a third Southern Arabia, and a fourth India and Ceylon.

Habits Evidently extremely specialized creatures, chamæleons stand altogether apart from the lizards, not only as regards their anatomical structure, but likewise in their power of moving one eye independently of the other, in the enormous extensibility and protrusive power of their tongues, and in their slow and deliberate movements. According, however, to those who have had the opportunity of observing them in their native haunts, chamæleons do not move quite so slowly as in confinement, where they take half a minute in determining which limb to move, or on which bough to replace it. Passing the whole of their lives in trees, like most of their Malagasy compatriots, the lemurs, chamæleons are chiefly

found only in regions where foliage is abundant, and where the fall of rain or dew is sufficient to supply them with the amount of moisture they need. Consequently, they are most numerous represented in coast districts and islands. A few, however, frequent such parts of desert regions as come under the influence of the sea moisture, and support a more or less scanty vegetation. Needless to say, all the species live on insects, and more especially flies of various kinds, which are caught by the viscid secretion of the tip of the protrusile tongue.

Being utterly defenseless creatures, and having a large number of enemies, chamæleons depend entirely upon their resemblance to their environment for protection; and for this end they have the power of changing color, although not apparently to such an extent as is the case with some lizards of the genus *Calotes*. At night they appear generally to be of a whitish-yellow hue, but with the first dawn of day assume the dark green color characteristic of most of the species, which exactly assimilates to the surrounding leaves, and continues to grow brighter and brighter with advancing day. When resting on a bough, or when captured in the hand, the color changes, however, to brown; this change in the latter case taking place with exceeding rapidity, and the skin sometimes becoming nearly black, with the disappearance of all the bright marking. This change, according to Miss C. C. Hopley, is due to anger; the creature at the same time emitting a sound something between a hiss and the chirp or squeak of a very young bird, and trying to bite its captor. "Meanwhile, it is all impatience to ascend, no matter where, so that it climbs upward. Up, up, always up; it may be your dress, or whatever is near. It seems to think it can be safe only at the top of something. And yet they are not found invariably on the upper branches of their bush, though generally rather high. Released from the hand, its anger soon subsides, so does the dark hue, and the creature assumes the tint of the surface on which it is placed, grayish, reddish, darker or lighter, green or yellow, as may be." Several individuals are not unfrequently met with on the same bush, where they cling tightly to the stems among the crowded leaves, being alike difficult to detect and to detach, and always exhibiting their displeasure at being disturbed by the aforesaid hissing sound. Absolutely still they remain, continues the writer just quoted, hour after hour, the only evidence of life about them being that revolving little globe of an eye, with its pupil turning as an axis, now up, now down, forward or backward, while its owner clings motionless as death. In repose the long tongue is folded up within the dilatable skin of the chin, where it has a special sheath for its reception; but it can be darted out with such speed as to take a fly at a distance of fully six inches. Although the majority of the species lay eggs, the pygmy chamæleon (*C. pumilus*) of the Cape, together with five nearly allied African species, produce living young, which may be as many as eleven in number. In confinement chamæleons quickly become tame, and, if allowed to rest in peace, after a few days cease to bite and hiss when handled, and soon venture to take a fly from their owner's hand.

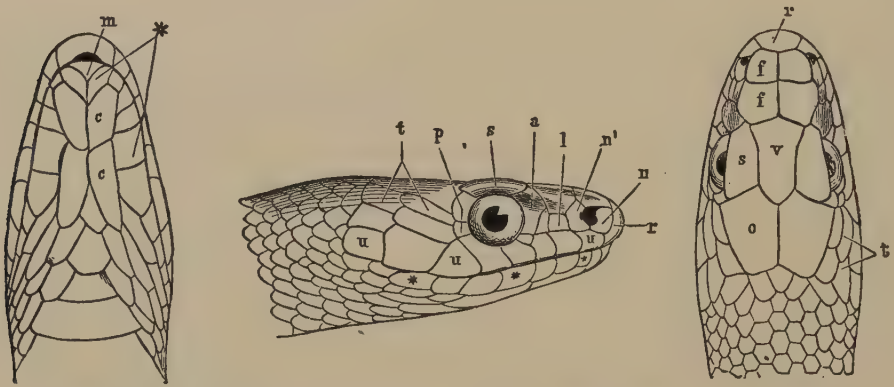
CHAPTER V

SCALED REPTILES—ORDER SQUAMATA—*continued*; THE SNAKES— SUBORDER OPHIDIA

**Distinctive
Character-
istics and
Structure** ORIGINALLY regarded as representing a distinct ordinal group of the Reptilian class, the snakes are now generally considered to form merely a suborder of the great assemblage of reptiles which includes both lizards and chamæleons; and from their close structural resemblance to the limbless lizards there can be no doubt that the more modern view is the true one. As a matter of fact, it is by no means easy to draw a satisfactory distinction between lizards and snakes; and such characteristics as naturalists rely on for their differentiation are mainly such as are due to adaptation to the special needs of the latter group. Agreeing with lizards in their external covering of scales, snakes are characterized by their exceedingly elongated and slender bodily conformation; the head, which is generally more or less flattened, being often not defined from the body by a distinctly marked neck, while external limbs are wanting, and the body passes posteriorly by imperceptible degrees into the tail. Occasionally, however, external vestiges of the hind-limbs may persist, in the form of a pair of small spur-like processes near the vent; and internally there may be traces not only of the pelvis, but likewise of the thigh bone or femur. None of these characteristics will, however, serve to distinguish snakes from the limbless lizards, and it is therefore necessary to point out how the two groups may be separated. The most characteristic peculiarity of snakes, as distinct from lizards, is the absence of a solid union between the two branches of the lower jaw, which are connected at the chin merely by an elastic ligament this arrangement permitting of the separation of the two halves of the jaw, and thus allowing the mouth to be dilated so as to be capable of swallowing prey of much larger dimensions than the normal width of the aperture. In addition to this arrangement, in the majority of snakes the bones of the upper jaw and palate are likewise movable, thus further increasing the capacity of the gape. From the great majority of lizards snakes are, of course, widely distinguished by the absence of functional limbs; while from the comparatively few limbless representatives of the same suborder, they differ in having the tongue completely retractile within a basal sheath, as well as by the presence of additional articulations to the vertebræ, which are described below. Moreover, none of the limbless lizards have the large shields on the inferior surface characterizing the majority of snakes, while most of them possess eyelids and an external aperture to the ear.

No snake has movable eyelids; that portion of the skin representing the lids extending as a convex transparent disc across the eye, and covering it as a watch

glass covers the face of a watch. When a snake changes its skin, which it does several times during the year, the discs over the eyes peel off with the rest, and appear as lenses in the dry slough. Equally characteristic is the absence of any external aperture of the ear, a peculiarity which has given rise to the scriptural expression of the deaf adder stopping its ears. Resembling that of lizards in its flattened form, the tongue of snakes is narrow and smooth, and terminates in a fork formed by two long thread-like points, while at its base it is inserted into a sheath from which it can be protruded at will. The head, although not very large, is generally wider than the body, from which, as already said, it is but seldom separated by a recognizable neck, and is usually oval or triangular in shape, with a more or less well-marked depression. Near the sides of its extremity, and sometimes at the very tip, are situated the nostrils; while posteriorly the gape in some cases extends almost to the back of the head. Superiorly, as well as on its under surface, the head is generally covered with a number of large symmetrical shields, having their edges



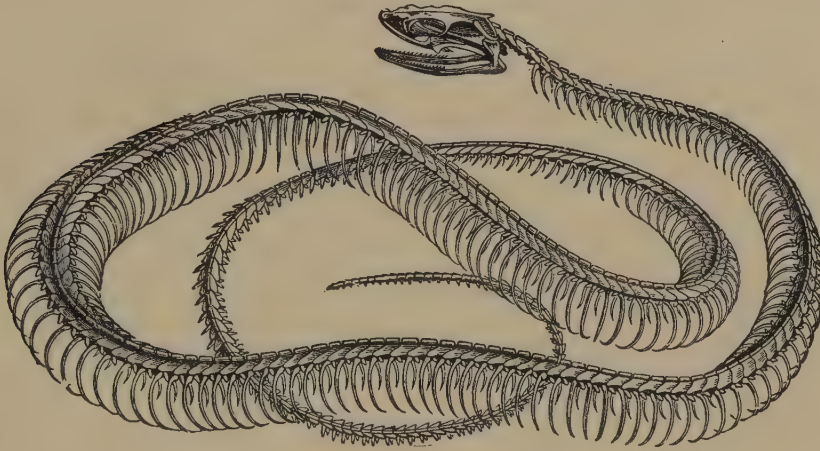
INFERIOR, LATERAL, AND SUPERIOR VIEWS OF THE HEAD OF A SNAKE.

r. rostral shield; *f.* anterior and posterior frontal do.; *v.* interparietal do.; *s.* supraocular do.; *o.* parietal do.; *nn¹.* nasal do.; *l.* loreal do.; *a.* preocular do.; *p.* postocular do.; *uu.* upper labial do.; *tt¹.* temporal do.; *m.* mental do.; **** lower labial do.; *cc.* chin shields.—After Günther.

in apposition, and varying in relative size in the different groups. Although the blind snakes have a uniform cuirass of polished scales all around the body, while some of the sea snakes also have the scales of the under parts similar to those of the back, in the great majority of the order the under surface of the body is protected by large transverse shields, extending completely across it from side to side. These broad shields often extend as far backward as the termination of the body proper; while at the commencement of the tail, and thence backward to the extremity, they are replaced by a double row. These large inferior shields take an important part in the progression of snakes on land, and hence we see why they are wanting in the marine forms.

In all snakes the number of joints in the backbone is very large; and each of these, with the exception of a few near the extremity of the tail, is provided with a pair of rather long, slender, and curved ribs, the extremities of which correspond to the large inferior shields of the body in the species where these are present. Super-

riorly the ribs, as shown in the figure on p. 2463, articulate by a single head with a facet on the side of each vertebra, in the same manner as in lizards. Only certain groups of lizards have the vertebræ with the additional articular facets on the front and back surfaces known as zygantra and zygosphenes, but in snakes (as shown in the figure below) these are invariably present; and it is owing to this complicated system of articulation that a snake is able to make the wonderful foldings and contortions characteristic of its kind without fear of dislocating its spine. It may be added that no snake has any trace of a breastbone, nor any vestige of a pectoral arch, there being no rudiments of either blade bone, coracoid, or collar bone. When progressing on a firm surface, an ordinary snake, in common with the limbless lizards, walks entirely by the aid of its ribs, which are but very loosely articulated to the vertebræ, and thus readily admit of a large amount of motion. In describing their mode of progression, Dr. Günther remarks that "although the motions of snakes are in general very quick, and may be adapted to every variation of



SKELETON OF SNAKE.

ground over which they move, yet all the varieties of their locomotion are founded on the following simple process: When a part of their body has found some projection of the ground which affords it a point of support, the ribs, alternately of one and the other side, are drawn more closely together, thereby producing alternate bends of the body on the corresponding side. The hinder portion of the body being drawn after, some part of it finds another support on the rough ground or a projection, and the anterior bends being stretched in a straight line the front part of the body is propelled in consequence. During this peculiar kind of locomotion, the numerous broad shields of the belly are of great advantage, as, by means of the free edges of those shields, they are enabled to catch the smallest projections on the ground, which may be used as points of support. Snakes are not able to move over a perfectly smooth surface." It may be added that a snake is only able to move by lateral undulations of its body in a horizontal plane; and that the pictures often seen in which these reptiles are depicted as advancing with the folds of the body

placed in a vertical plane are altogether erroneous. In conformity with their elongated bodies, the internal organs of snakes are long and narrow; and it is remarkable that, as a rule, only one of the lungs is developed.

Teeth Resembling the other members of the order to which they belong in that their teeth are never implanted in distinct sockets or grooves, snakes exhibit some considerable degree of variation with regard to the number and structure of their teeth. In the ordinary harmless forms there are generally two rows of short, slender, and sharply-pointed teeth in the upper jaw, the innermost of which are attached to the bones of the palate, while the lower jaw carries only a single row of such weapons. One or two of the outer row of upper teeth, either at the front or back of the series, may, however, be enlarged beyond the rest, and grooved or tubular; and it is probable that all snakes with such a dental armature are more or less venomous. Some most deadly poisonous serpents have, on the other hand, a type of dentition of their own; and there is no doubt that all snakes with teeth of this nature are extremely venomous. In such snakes the fore part of the very short maxillary bone of each side of the upper jaw is armed with an elongated tubular tooth, which ordinarily lies nearly flat on the surface of the palate, but can be erected, by a peculiar mechanism of the bones, when the jaws are opened. Although in this group the poison fangs are always tubular, in some of the other venomous serpents they are merely grooved for the conveyance of the venom from the secreting gland; but there is a transition between the two types, as the closed tube is formed merely by the edges of the groove being elevated until they unite in the middle line. In poisonous snakes, on each side of the upper jaw, below and behind the eye, is situated the poison gland—merely an ultra development of an ordinary salivary gland, these glands in some cases being so developed as to extend far back along the sides of the body. The gland is overlain by a layer of muscles, for the purpose of forcing the secretion into the tooth (the base of which is always open) when required, this action always taking place when the snake opens its mouth to bite. The poison then flows along the channel or tube of the tooth, and is discharged at its extremity into the wound. Considerable force is used in the emission of the poison, as, when a snake is irritated, the fluid may be seen to spurt for some distance from its point of discharge. In some of the less specialized poisonous snakes, the venom tooth, which has an open channel, is not greatly longer than the others, and is placed nearly vertically when the mouth is closed. Although the poison teeth are commonly regarded as purely defensive weapons, their chief use is for the destruction of the prey of their owners, which is always killed before being swallowed. The venom tooth of the more specialized poisonous snakes is exceedingly likely to be broken off during use; but to take its place there are always several others lying on the gum behind it in different stages of development.

Harmless and Poisonous Snakes Before the doctrine of parallelism in development received from naturalists the attention it undoubtedly merits, snakes were generally divided into harmless and poisonous groups; but since we have become better acquainted with that important factor in evolution, it has been recognized that such a distinction is a purely artificial one, and has noth-

ing to do with real affinity. Certain groups of snakes, such as the members of the viper family, may, however, be wholly poisonous; while in other groups, such as the typical snakes, some species may be venomous and others innocuous. Many attempts have been made to draw up a list of characteristics by means of which the harmless members of the suborder can be distinguished at a glance from those which are hurtful. On this point Mr. Boulenger writes "that there is no sure method of distinguishing the two kinds of external characteristics; except, of course, by a knowledge of the various forms. And even then, a cursory examination is not always sufficient, since there is, in some cases, a striking resemblance between snakes of totally different affinities, by which even specialists may at first be deceived. In short, nothing but an examination of the dentition can afford positive information as to the poisonous or nonpoisonous nature of an unknown snake."

Distribution

Geologically speaking, snakes are a comparatively-modern group, being scarcely known below the lowest portion of the Eocene division of the Tertiary period, although one or two forms have been described from the underlying Cretaceous rocks, and one has recently been recorded from the Gault of Portugal — a formation underlying the Chalk. It is noteworthy that one of the North American lower Eocene snakes has the additional articular facets of the vertebræ but very imperfectly developed; and there can be little or no doubt but that the whole group is an offshoot from the lizards. From the commencement of the Tertiary period, the group seems to have gone on steadily increasing in numbers; and it is now represented by some fifteen hundred species, ranging all over the world except New Zealand. Snakes are, however, much more abundant in the moist tropical regions of the globe than in colder regions, and it is there only that they attain their maximum development in point of size. India and the Malayan countries, where there are representatives of the whole of the nine families into which the suborder is divided, are the home of a greater number of both genera and species of snakes than any other part of the world. Tree snakes are very common in this region, while the gigantic pythons are shared by it in common with Africa. The proportion of poisonous to innocuous species is likewise very high in the Oriental region, and has been estimated at about one in ten. Africa has scarcely half the number of snakes found in the Oriental region; and it is noteworthy that the forms inhabiting Madagascar have but little in common with those of the mainland; the so-called lycodonts, which are so common in Africa, being unknown in Madagascar, while some of the forms from that island are closely allied to South-American types. Whereas pit vipers are absent, an especial feature of Africa is the number of typical vipers which inhabit that country; and Australia, which differs so remarkably from India in its tortoises, possesses snakes (and likewise lizards) closely allied to Oriental forms. Next to the Oriental region, tropical America is richest in ophidians, although the number of generic types is not so great. The proportion of poisonous species is, however, high, and has been estimated at as much as one in eight. In Southern Argentina and Patagonia snakes become scarce. Unlike its Chelonians, the snakes of North America present a resemblance to those of Central America. Indeed, a feature of the whole of America

is the absence of typical vipers, and the abundance of pit vipers, although several genera of the latter are common to Asia. Europe and Northern Asia are comparatively poor in snakes, but (next to Africa) are characterized by the number of typical vipers and colubrine water snakes.

Habits Although a few members of the suborder subsist on eggs, snakes as a rule capture and devour living animals, which are in all cases swallowed whole, as these reptiles have no apparatus for rending or masticating their food. And it is in order that they may be able to swallow larger animals than would otherwise be possible, that they have the power of dilating their jaws in the manner already indicated. Not only can the jaws be thus enlarged, but the throat and stomach are capable of dilatation, owing to the circumstance that the lower ends of the ribs, from the absence of a breastbone, are quite free; and in swallowing, a snake seems gradually to draw itself over the object to be devoured. The majority of snakes devour their prey alive, and a frog may be seen struggling in the stomach of a common English water snake long after it has been swallowed. Other snakes, however, kill their prey either by striking it with their poison teeth, after the manner of the vipers, or by encircling and smothering it in the folds of the body, like the boas. Although the process of digestion is very rapid, snakes feed but seldom; and it has been asserted that two or three frogs are sufficient to supply the needs of the English water snake for a whole year. All snakes drink much, water being absolutely essential to their existence.

As might have been expected from their numbers, snakes exhibit great diversity in their modes of life; and while those of the tropical regions remain active throughout the year (unless they lie by during periods of drought) the species inhabiting colder regions hibernate during the winter. The most remarkable diversity from the ordinary mode of ophidian life is displayed by the blind snakes, which lead a completely subterranean existence, very seldom making their appearance above the surface. The great majority of serpents are terrestrial in their habits, seldom entering the water or climbing trees; and these ground snakes, as they may be called, are characterized by their cylindrical form and the width of the shields on the inferior surface of the body. Tree snakes, on the other hand, which are mostly remarkable for their brilliant coloration, lead an almost completely arboreal life. Frequently they have the body very slender, or the shields on its under surface may be keeled in order to afford a firmer hold in climbing; in other instances the tail is prehensile. It is among this group that the egg-eating species are found. Then, again, we have fresh-water snakes, which swim and dive with facility in the waters of rivers and lakes, where they spend a large portion of their time, feeding on such aquatic creatures as they can capture therein. As a rule, these snakes are distinguished by having the nostrils placed at the top of the muzzle, and likewise by the tapering form of the tail. Lastly we have the sea snakes, which, while having the nostrils situated as in the last group, are distinguished by the lateral compression of their tails. In all cases extremely poisonous, these snakes are almost entirely pelagic in their mode of life, and seldom approach the land, although in one genus the shields on the under surface of the body are sufficiently developed to admit of terrestrial progression.

By far the greater majority of the members of the suborder lay eggs of an oblong form and inclosed in soft leathery shells, which are hatched by the natural heat of the places where they are deposited. The pythons, however, incubate their eggs, and at such periods develop a temperature a few degrees above that of the surrounding air. On the other hand, both in the fresh-water and sea snakes the eggs are retained within the body of the mother until they are hatched.

THE BLIND SNAKES

Families *TYPHLOPIDÆ* and *GLAUCONIIDÆ*

The blind snakes, which are now arranged under two families, are small, worm-like creatures, with cylindrical bodies and short heads and tails, entirely adapted for a subterranean burrowing life. Lacking the large inferior transverse shields, characterizing ordinary snakes, the blind snakes have the body and tail covered on all sides with round overlapping scales of equal size on both the upper and lower surfaces; while there are large shields on the fore part of the head, one of which on each side covers the rudimentary eye. The cleft of the mouth, which is very small, is placed on the lower surface of the head, and the jaws admit of scarcely any dilatation. An important point of difference from all the other members of the suborder is that teeth are absent in either the upper or lower jaws, while in all cases larger or smaller vestiges of the pelvis remain. The most important distinction is, however, to be found in the palate of the dried skull, which differs from that of all other snakes in lacking the so-called transverse or transpalatine bone, which connects the pterygoid or hindmost bone of the palate with the posterior extremity of the jawbone or maxilla. In the first, or typical family of the blind snakes, the upper jaw, which is but loosely attached to the rest of the skull, is furnished with teeth, while the lower jaw is toothless, the pelvis being represented merely by a single bone on each side. On the other hand, in the second family (*Glaconiidae*) while the upper jaw is devoid of teeth, there are a few teeth in the lower one, the pelvis being represented by a pair of bones on each side, of which the two anterior ones meet in the middle line. As regards their origin, it seems probable that the blind snakes have little or no near relationship with the other members of the suborder to which they belong.

The typical blind snakes, or those belonging to the first of the two families, are inhabitants of all the warmer regions of the globe, and are represented by nearly a hundred species arranged under three genera. By far the greater number of these species belong to the genus *Typhlops*, which has a distribution coextensive with that of the family; the other two genera, namely, *Helminthophis* with five species, and *Typhlophis* with one, being confined to Central and South America. The second family contains only the single genus, *Glauconia*, of which there are nearly thirty species, found in America, Africa, and Southwestern Asia. Very little has been recorded in regard to the habits of these curious snakes, although it is ascertained that they lay eggs, which are few in number, large in size, and

elongate .n form. Although they generally remain in their subterranean burrows, in showery weather these snakes not unfrequently come to the surface for a short time. The remains taken from their stomachs show that they feed largely upon millipedes and ants, and they probably also consume the larvæ of many insects. Captive specimens have been observed to drink freely. The European blind snake (*Typhlops vermicularis*) is an inhabitant of Greece and several of the adjacent islands, Asia Minor, Syria, Arabia Petræa, and the Caucasus as far as Transcaspia.

THE PYTHONS AND BOAS

Family *BOIDÆ*

Including the largest of living snakes, this family is now regarded as being the most generalized of the entire suborder (exclusive of the blind snakes), all the others presenting such characteristics as would admit of their having taken origin from ancestral types belonging to the one under consideration. In common with the remaining families, the boas and pythons differ essentially from the blind snakes in that both jaws are fully toothed, and likewise in the presence of a transverse bone to the palate. The characteristics specially distinguishing the present from the other families of the suborder are, unfortunately, largely derived from the structure of the skull, and therefore require some degree of anatomical knowledge for their proper appreciation, while they cannot be described without the use of a considerable number of technical terms. It may be mentioned, however, that the lower jaw has on the inner side of each branch a thin bone known as the coronoid; while on the top of the skull the prefrontal bones, which lie on the outer side of the fore part of the frontals, articulate with the nasal bones, or those roofing the front of the cavity of the nose. In the hinder part of each side of the skull lies a large bone, termed the supratemporal, from which is suspended the quadrate bone for the articulation of the lower jaw; while a further important characteristic is to be found in the presence of vestiges of the pelvis and hind-limbs, the latter usually taking the form of a claw-like spur situated on either side of the vent. The family, which contains a very large number of genera and species, has an extensive geographical distribution, being represented in Southeastern Europe, Central and Southern Asia, Africa, Australia, the West Indies, Western North America, and Central and South America; it is thus essentially characteristic of the warmer regions of the globe. Pythons belonging to extinct genera lived on the Continent and in England during the earlier part of the Tertiary period.

True Pythons The large snakes to which the term python properly belongs are the typical representatives of the first of the two subfamilies into which the *Boidæ* are divided; the essential feature of this subfamily (*Pythoninæ*) being the presence on the upper aspect of the skull of a supraorbital bone lying on each side of the frontal bones, and forming the upper border of the socket of the eye. Agreeing with three other less important genera in the presence of teeth in the premax-

illæ or anterior upper jawbones, and also in generally having two rows of shields on the under surface of the tail, the pythons are specially characterized by the distinctly prehensile tail, and likewise by the presence of deep pits in the rostral and anterior upper labial shields of the head. As minor characteristics, it may be mentioned that the teeth, none of which are grooved, gradually decrease in size from the front to the back of the jaws; while the eye is of moderate size, with a vertical pupil. The head is distinct from the neck, and has the extremity of the snout covered with large shields, while its hinder portion may be overlain either with sym-



INDIAN PYTHON CRUSHING ITS PREY.
(One-tenth natural size.)

metrical shields, or with small scales; and each nostril is placed in a half-divided nasal shield, separated from its fellow on the opposite side by a pair of internasal shields. The body in these snakes is more or less compressed, while the scales on the upper surface and sides are small and smooth; and the prehensile tail is of moderate length, or short, with the whole or greater part of the inferior shields arranged in two rows.

Distribution and Habits Pythons, or, as they are frequently termed, rock snakes, are represented by nine species, and range over tropical and South Africa, Southeastern Asia, and Australasia. With the exception of the American anaconda, some of the pythons are the largest of all snakes, and although

there has been much exaggeration in this respect, it is now ascertained that the Indian python (*Python molurus*), represented in the figure on p. 2543, occasionally attains a length of thirty feet, while the West-African python (*P. sebae*) is stated to reach twenty-three feet. It is, however, but seldom that pythons of more than from fifteen to twenty feet in length are met with, and these are sufficiently formidable creatures, since they have a circumference as large as a man's thigh, and easily kill such animals as small deer, full-grown sheep, and dogs of considerable size. They are, however, unable, according to Dr. Günther, to devour animals of larger dimensions than a half-grown sheep. A python destroys its victim in much the same manner as do many of the smaller snakes, gradually smothering it by throwing over it coil after coil of its body. In swallowing, writes Dr. Günther, pythons "always commence with the head [as shown in the figure of the African species], and as they live entirely on mammals and birds, the hair and feathers offer a considerable impediment to the passage down the throat. The process of deglutition is, therefore, slow, but it would be much slower except for the great quantity of saliva discharged over the body of the victim. During the time of digestion, especially when the prey has been a somewhat large animal, the snake becomes very lazy; it moves itself slowly when disturbed, or defends itself with little vigor when attacked. At any other time the rock snakes will fiercely defend themselves when they perceive that no retreat is left to them. Although individuals kept in captivity become tamer, the apparent tameness of specimens brought to Europe is much more a state of torpidity caused by the climate than an actual alteration of their naturally fierce temper." In their general habits snakes of this genus are nocturnal, and they generally live on or among trees in the neighborhood of water, frequently swimming in the water. The reticulated python (*P. reticulatus*) of Burma and the Malayan Archipelago, which attains a length of some sixteen feet, not unfrequently takes up its abode in buildings, whence it issues forth at night to capture such prey as it can find.

It had long been reported by travelers in India that pythons incubated their eggs, and although such reports were received with incredulity, their truth was established in 1841, when an African python in the Jardin des Plantes, Paris, laid fifteen eggs on the sixth of May, which she subsequently proceeded to incubate. When first laid, the eggs, which were completely separate, were soft, oval, and ashy gray, but they soon assumed a rounder form, and a clear white tint, at the same time hardening. The parent collected them into a cone-shaped pile, around which she rolled herself in such a manner as to conceal the whole number, with her head forming the summit of the cone. For upward of six-and-fifty days this position was maintained without movement, except when persons attempted to touch the eggs. On the second of July the shell of one of the eggs split, revealing a fully-formed python within, and on the next day the little creature came forth into the world. During the four succeeding days, eight more snakes made their appearance, but the rest of the eggs were spoilt. In from ten days to a fortnight the young pythons changed their skins, after which they caught and devoured some live sparrows, seizing and smothering them in the manner in which full-grown individuals destroy prey of larger size.

Species of
Python

According to Mr. Boulenger, the number of species of python is nine, which may be divided into two groups, according as to whether the number of pairs of shields on the lower surface of the tail exceeds or falls short of fifty. The former group may be further subdivided into two sections, according as to whether the number of scales in a row round the thickest part of the body varies from thirty-nine to sixty, or from sixty-one to ninety-three.



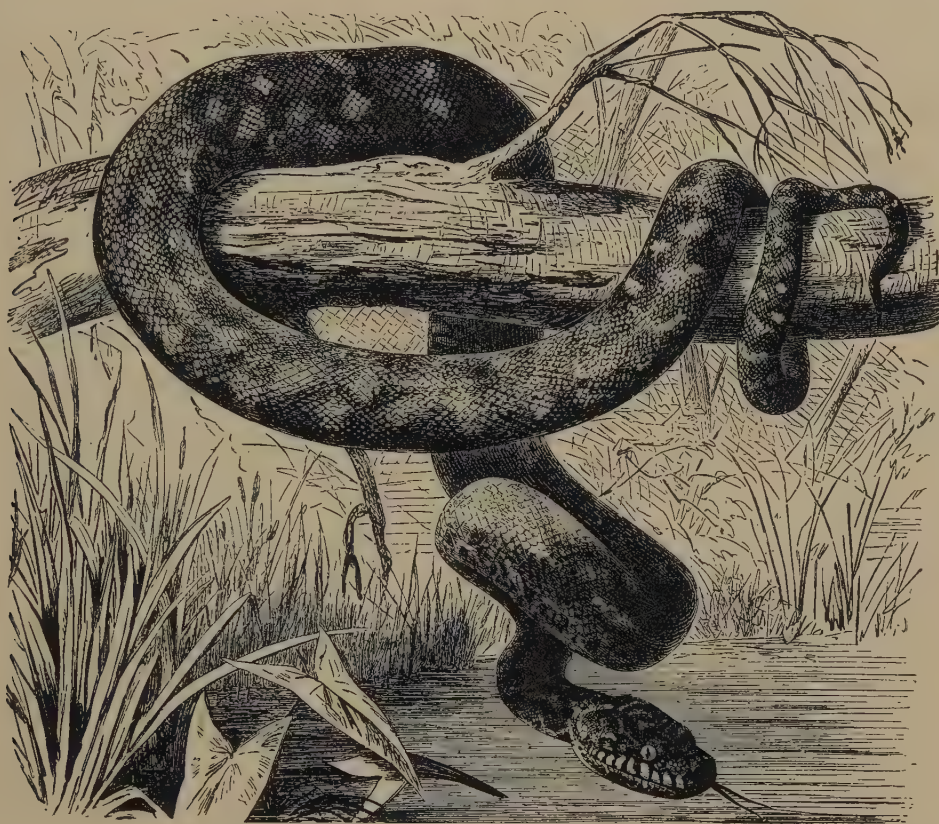
AFRICAN PYTHON SWALLOWING A BIRD.
(One-eighth natural size.)

The first representative of the former of these subgroups is the Australian diamond snake (*P. spilotis*), represented in the illustration on p. 2547, which is characterized by the crown of the head being covered with scales or small irregular shields, and the presence of pits on two or three of the upper labial shields of the snout. This snake, which was formerly referred to a genus apart (*Morelia*), is an inhabitant of New Guinea and Australia, and is of comparatively-small size, attaining a total length of only about six and one-half feet; its coloration being extremely variable.

The variety in which the skin is most spotted was long regarded as a distinct species, under the name of the carpet snake. The other two members of this group are the amethystine python (*P. amethystinus*) and the Timor python (*P. timorensis*), both distinguished by the presence of large symmetrical shields on the crown of the head, and by four upper labial shields being pitted. The former, which grows to a length of about eleven feet, ranges from the Moluccas and Timor to New Guinea, New Ireland, New Britain, and the north of Queensland; while the latter is restricted to the islands of Timor and Flores. The second subgroup, or the one with from sixty-one to ninety-three scales round the body, includes three species, of which the Malayan reticulated python (*P. reticulatus*) has from sixty-nine to seventy-nine scales in a row, and four upper labials with pits. This species, which ranges from Burma and the Nicobar islands to the Malayan region and Siam, is one of the largest of the genus, occasionally reaching upward of thirty feet in length. In color, it is light yellowish or brown above, ornamented with large circular rhomboidal, or X-shaped dark markings; the head has a median black line, and the under parts are yellowish, with small brown spots on the sides. It is, however, subject to considerable variation, a specimen from Siam in the London Zoological Gardens showing bright yellow lines on the sides. Young specimens show three longitudinal rows of light spots with black edges along the back. Somewhat smaller is the African python (*P. sebae*), of tropical and South Africa, which attains a length of about twenty-three feet, and has from eighty-one to ninety-three scales in a row on the thickest part of the body, and only two of the labial shields pitted. This species occurs typically in West Africa, from which region came the specimen represented in the illustration on p. 2545 in the act of swallowing a bird; and it was long considered that the South-African python or Natal rock snake was a distinct species. Its color is pale brown above, with dark brown, black-edged, and more or less wavy crossbars, usually connected by an interrupted or continuous dark stripe running along each side of the back; the sides are marked with large black spots and small dots. On the top of the head is a large triangular dark brown blotch, which is bordered on each side by a light stripe commencing above the nostril at the end of the muzzle, and passing above the eye; and there is a dark stripe on each side of the head, and a somewhat triangular blotch beneath each eye. The upper surface of the tail has a longitudinal light stripe bordered on each side by a dark one, and the under parts are spotted and dotted with dark brown. In India, Ceylon, the south of China, the Malay Peninsula, and Java, the last-named species is replaced by the Indian python (*P. molurus*), represented in the illustration on p. 2543 in the act of strangling a chevrotain. While agreeing with the last in having only two of the labial shields pitted, it differs in having from sixty-one to seventy-five scales in a row, and likewise in that the rostral shield is broader than long, instead of with these two diameters equal. In color, this python is grayish brown or yellowish above, with a series of large elongated squared reddish-brown black-edged spots down the middle of the back, flanked by a series of smaller ones. The head and nape of the neck have a spear-shaped brown mark, and a brown band runs on each side of the head through the eye, while there is a vertical one of this color beneath the latter. The under parts are yellowish, with the sides spotted

with brown. Known in India by the name of adjiga, this python ranges through Peninsular India, Rájputána, and Bengal, to the foot of the Himalayas, and is not uncommon, but in Ceylon, the Malay Peninsula, and Java, it is rare. It does not commonly exceed twelve feet in length.

The three remaining species of the genus form the second main group, in which there are less than fifty pairs of shields on the lower surface of the tail; the number of shields in a row at the thickest part of the body varying from fifty-three to sixty-three, and neither of the species being of very large size. The best known of the



AUSTRALIAN DIAMOND SNAKE.
(One-eighth natural size.)

three is the royal python (*P. regius*) of Senegambia and Sierra Leone, which is generally represented in the collection of the London Zoological Gardens; the other two being the rare Anchieta's python (*P. anchietae*) of Benguela, and the Sumatran python (*P. curtus*).

Allied Genera The subfamily of the *Pythoninæ* is represented by six other genera, which demand merely a brief reference; the first three of these agreeing with the typical genus in the presence of teeth in the premaxillary bones, while in the remainder that portion of the upper jaw is toothless. From the pythons the

first three genera may be distinguished by the tail being but very slightly, if at all prehensile, and by the rostral shield of the head being either devoid of pits, or with only very shallow ones. The first genus (*Loxocemus*), as represented by a single comparatively-small Mexican species (*L. bicolor*), has no pits in the labial shields, no loreal shield, and the nostril situated in a single nasal shield. *Nardoa boa*, of New Ireland, alone represents the second genus, and may be distinguished by the presence of pits in the lower labial shields, and by the laterally placed nostril being situated between two nasal shields. On the other hand, the third genus, *Liasis*, is represented by several species ranging from Flores and Timor to Papua and the north of Australia; and may be distinguished from the second by the nostril being placed more superiorly in a half-divided nasal shield. Finally, three genera in which the anterior jawbones, or premaxillæ, are toothless are *Chondropython*, with one Papuan species; *Aspidites*, represented by two species from the north of Australia, and *Calabaria*, with a single West-African representative. The interest attaching to these snakes is the connection which they form between the pythons and the boas. Thus while the first two differ from the typical pythons and resemble the boas in the presence of teeth on the palate, the second and third likewise agree with the latter in having the shields on the lower surface of the tail mostly or entirely single; the tail itself being but slightly, if at all prehensile.

The tree boas of tropical America may be taken as examples of the second subfamily (*Boinae*) of the assemblage of snakes under consideration. The members of this subfamily can be distinguished from the preceding group solely by the absence of a supraorbital bone on the upper surface of the skull above the socket of each eye. They further differ from all the pythons, with the exception of two of the three genera last mentioned, in having teeth on the palate; and, with the exception of the whole three of the connecting genera, in the absence of teeth in the anterior upper jawbones, or premaxillæ. Moreover, the boas and their allies further differ from the typical pythons in having the shields on the lower surface of the tail for the most part single, thereby agreeing with the genera *Aspidites* and *Calabaria*, and thus showing that the small group to which the two latter belong forms such a close connection between the pythons and boas as to preclude their reference to separate families.

In common with the majority of the thirteen genera, into which the subfamily is divided, the tree boas are characterized by having the head distinctly defined from the neck, and the tail more or less prehensile. They are specially distinguished by the anterior teeth being much larger than the hinder ones; by the smooth scales of the body; by the presence of shields on the head, and by the labial shields being either devoid of pits or with only shallow ones. In form the body is more or less compressed, and the tail either moderate or long; the eye is of medium size with a vertical pupil, and the shields on the head may be either small and irregular, or large and symmetrical.

These snakes are represented by nine species, the largest of which is the pale headed tree boa (*Epicrates angulifer*) of Cuba, attaining a length of about seven feet; another well-known species being the streaked tree boa (*E. striatus*) from San Domingo and the Bahamas. The thick-necked tree boa (*E. cenchris*), must,

however, be mentioned, its habitat ranging from Costa Rica to the northern districts of Peru and Brazil. The figured species, which attains a length of about five feet, is either pale brown above with dark olive-brown spots separated by narrow intervals from one another, or brown with wavy or zigzag yellowish cross bands, not unfrequently margined with blackish brown. Each side of the head usually has a more or less distinct streak behind the eye; the under parts are pale olive or yellowish, more or less spotted with brown or black.



STREAKED TREE BOA.

(One-fifth natural size.)

**Dog-Headed
Tree Boa**

Closely allied to the last, the five species of the genus *Corallus* are distinguished by having deep pits in the labial shields of both the upper and lower lips. The body is compressed, with small smooth scales, and the prehensile tail is either short or more or less elongated. This genus has a somewhat remarkable distribution, four of its representatives being inhabitants of tropical America, while the fifth (*C. madagascariensis*), which is distinguished from the rest by the shortness of its tail, is restricted to Madagascar. The dog-headed tree boa (*C. caninus*) is a native of the Guianas and Brazil, and usually attains a length of some five feet, although it may be considerably larger. It belongs to a group of two American species distinguished from the other kinds

inhabiting the same countries by the relatively-shorter tail, which has only from sixty-four to eighty-two shields on its inferior surface; whereas in the true tree boa (*C. hortulanus*), and another species, there are at least a hundred of these shields. The species here figured is specially characterized by having the scales arranged in sixty-one or seventy-one rows, and by the number of shields on the under surface of the body ranging from one hundred and eighty-eight to two



DOG-HEADED TREE BOA.
(One-sixth natural size.)

hundred and nineteen, while those on the tail vary from sixty-four to seventy-nine. In color this snake is decidedly handsome, the upper parts of the adult being bright green, ornamented with irregular spots and crossbars of white, and the under parts bright yellow. In the young the ground color is yellowish, and the white markings are edged with dark green or purplish black. Most abundant in the neighborhood of the Amazons, this species becomes more rare in Guiana, while

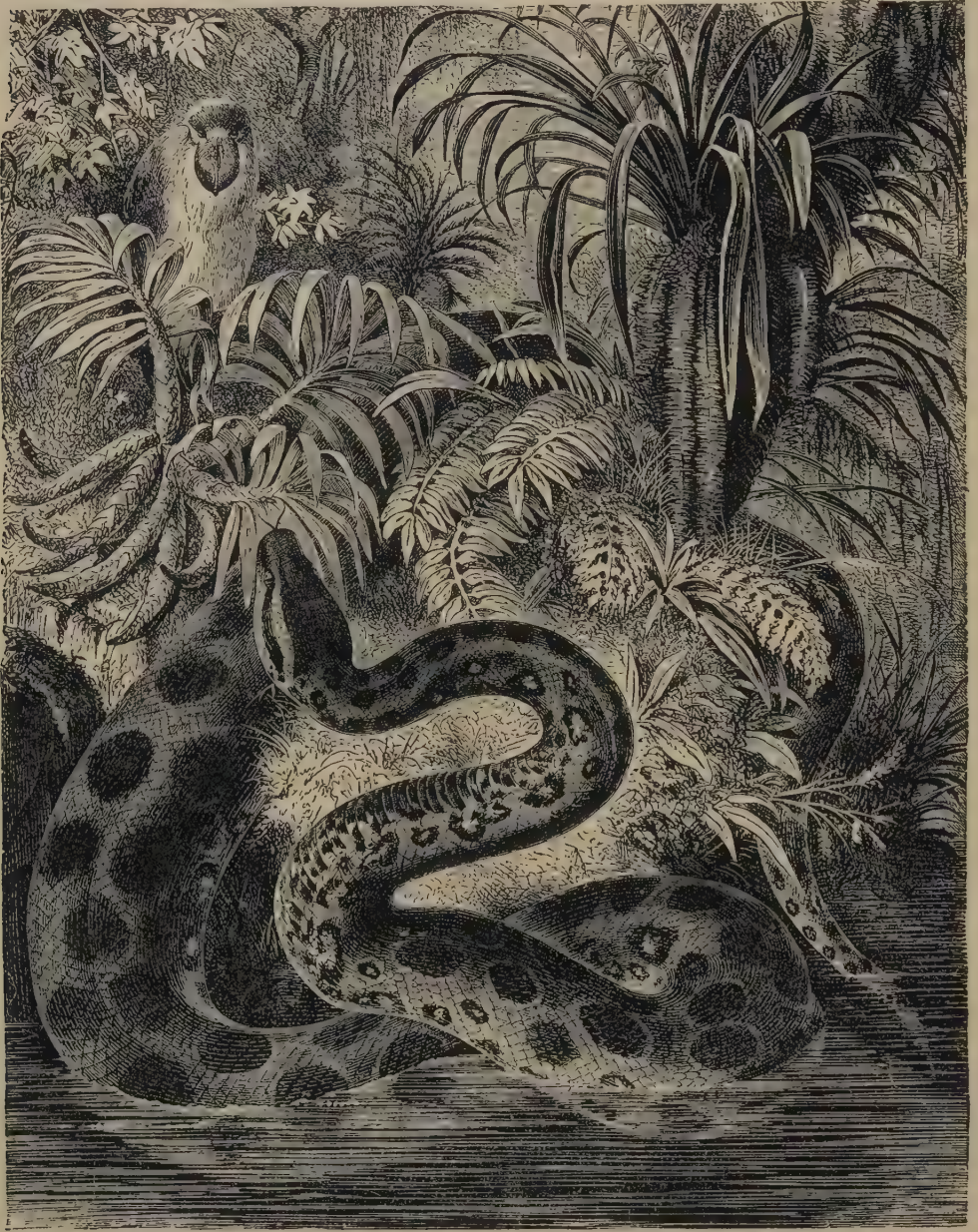
southward it likewise diminishes in numbers in lower Brazil. Feeding principally upon birds, the dog-headed boa is an excellent swimmer, and has been observed both in the Rio Negro and in the salt water of the beautiful harbor of Rio de Janeiro. Although it frequently visits the huts of the Brazilian negroes in search of prey, it does not appear that this snake ever voluntarily attacks human beings. If, however, it is driven to bay and unable to escape, it is capable of inflicting very severe bites with its long front teeth, such wounds being difficult to heal.

Keeled Tree Boas A third genus of tree boas (*Enygrus*) is distinguished from both the preceding by the scales having distinct keels; the labial shields of the head being devoid of pits, and the tail short and prehensile, with a single row of shields on its inferior surface. This genus is represented by four species inhabiting the Moluccas, the Papuan region, and Polynesia.

Anaconda This gigantic snake is the sole member of a group of several genera, distinguished from the tree boas by the teeth gradually decreasing in size from the front to the back of the jaws without any marked enlargement of those in the fore part. Merely mentioning the allied tropical American genera, *Trachyboa*, *Ungalia*, and *Ungaliophis*, the first and last of which are each represented only by a single species, we may observe that the anaconda is specially distinguished as a genus by the large size of the rostral shield of the head, behind which one pair of the nasals come in contact with one another in the middle line, and by the very small size of the smooth scales of the body. The head is markedly distinct from the neck; the nostrils are directed upward and placed between three pairs of nasal shields, of which the hindmost are those which meet in the middle line; the small eye has the pupil vertical; the body is cylindrical, and the tail is short and slightly prehensile, with a single row of shields inferiorly. In color the anaconda is grayish brown or olive above, with either one or two series of large blackish transverse spots, and a single or double row of lateral eye-like spots having whitish centres and blackish rims. The upper part of the head is dark and divided by a black streak, terminating in a point on the muzzle, from the lighter cheeks; while another oblique black streak runs on each side behind the eye; the under parts being whitish with blackish spots.

The anaconda (*Euneces murinus*) is an inhabitant of the Guianas, Brazil, and Northeastern Peru, and is essentially an inhabitant of tropical forest regions. That it is the largest of all living snakes there can be little doubt, but the precise limits of size to which it may occasionally attain cannot be ascertained. A stuffed example in the British Museum has a total length of twenty-nine feet, and the species is commonly stated to reach thirty-three feet, while, if native reports are to be trusted, individuals of much larger size are occasionally met with. Although naturalists are generally indisposed to credit the existence of monsters of forty feet, or even more, we confess that personally we are unable to share their incredulity, as it is very improbable that the largest specimens have come under European observation. From all accounts, it appears that the anaconda generally spends more of its time in the water than on land, frequently floating down rivers with the current, and at other times lurking in quiet pools with only its head raised

above the surface of the water. In such situations, or resting on rocks, stranded tree trunks, or sand banks, it lies in wait for its prey. It, however, frequently



THE HOME OF THE ANACONDA.

leaves the water to pass a longer or shorter period on shore, when it may be found either in trees, among rocks, or even on hot sand; and it appears that when

in a tree this snake will often dart down its head from a considerable height to seize a passing peccary or other animal. Bates tells us that the anaconda will occasionally seize human beings, and this statement is fully confirmed by other observers. In Brazil, where water is abundant throughout the year, this snake is active at all seasons, although it is stated to display the most activity during the hot months of December, January, and February. In other districts, however, according to Humboldt, during the dry season, it is in the habit of burying itself deep in the mud of the dried-up rivers, where it is sometimes disinterred by the natives in a torpid condition. Very little is known with regard to the breeding habits of the anaconda. Since, however, females have several times been killed, containing eggs with embryos far advanced inside them, it would seem that the young are born alive. When they first make their appearance in the world, the young are reported to take to the water, although they soon leave it to pass a large portion of their time in trees.

Long supposed to be exclusively a tropical and South-American group, the true boas are common to the hotter regions of America and Madagascar. From the anaconda, the boas may be distinguished by the whole of the nasal shields being separated in the middle line by small scales. The body may be either cylindrical or slightly compressed, and the short and more or less prehensile tail may have either the whole or a portion of the shields on its lower surface arranged in a single series. In America the genus is represented by five species, two of which range as far south as the inland districts of upper Argentina. All species are characterized by having the loreal region of the head covered either with a single small shield or with small scales, and by the number of rows of shields on the under surface of the tail ranging from forty-five to sixty-nine. On the other hand, in the Malagasy boas (*Boa madagascariensis* and *dumerili*) there are several shields on the same region of the head, while the number of rows of shields beneath the tail is only from twenty to forty-one. The best-known representative of the genus is the common boa, or boa constrictor (*B. constrictor*), which ranges in South America from Venezuela to upper Argentina. At times reaching as much as twelve feet in length, it has the muzzle slightly prominent in the adult, although obliquely truncated in the immature state. In general color it is pale brown on the upper parts, with from fifteen to twenty dark brown crossbars, which expand inferiorly, sometimes to such an extent as to become connected on the sides of the body, and thus to surround oval or elliptical spots of the light ground color; the expanded portion of each bar having a light longitudinal line. On the sides are a series of large light-centred dark brown spots, most of which alternate with the crossbars; and on the tail all the markings become relatively larger of a brick-red color, margined with black, and separated by yellowish intervals. From the muzzle to the nape runs a dark brown median streak, widening posteriorly, where it may be looped; another bar of the same color passes on each side of the head through the eye, while there is a third below the latter, and the lips are marked by such bars; the rostral shield of the snout being also ornamented with a crescentic blackish mark. The under parts are yellowish, with spots and dots, or merely dots, of black. The whole tone of coloration is dull, sombre, and

adapted to harmonize with the shades of brown, black, and yellow on the bark of tropical forest trees.

Could we but see the boa during the night in the depths of its native forests—at which time alone it is thoroughly active—we should doubtless obtain a very different idea of the creature than that which we gather from the inspection in the daytime of the lethargic specimens in menageries. Lying coiled on the branch of some large tree, with its head projecting ready to be darted on its prey with the rapidity of lightning, the boa is generally unobserved by the passing traveler unless it happens to make a dart at an unfortunate dog belonging to his party. Feeding



COMMON BOA.
(One-eighth natural size.)

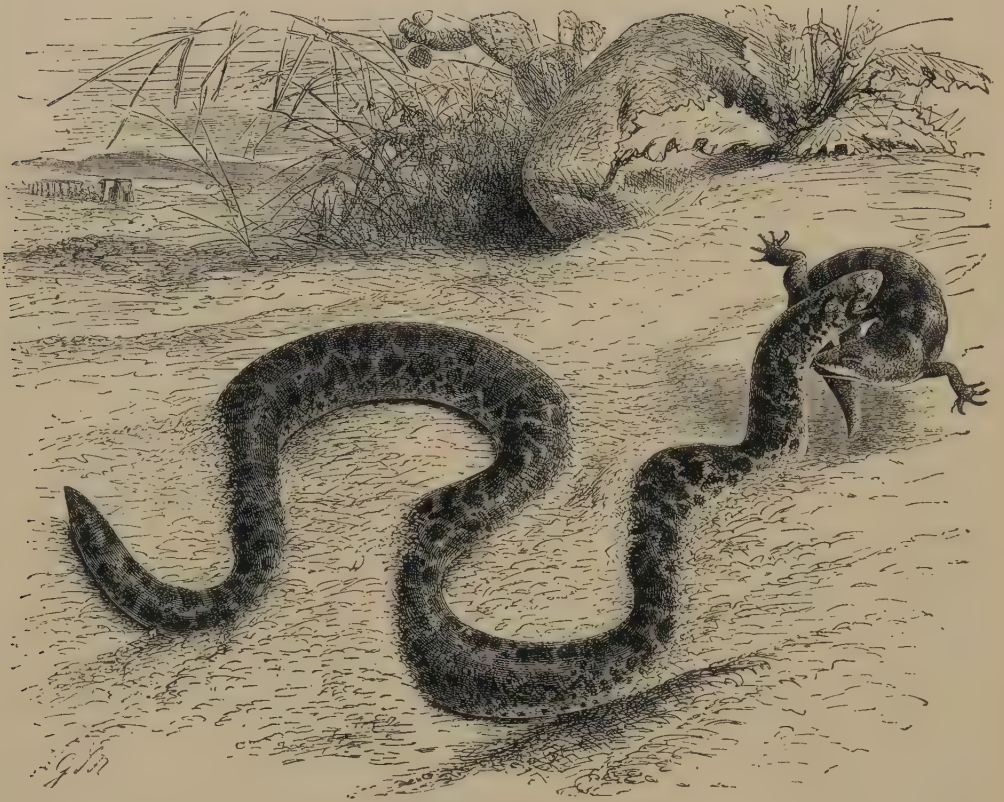
generally on such mammals as agutis, pacas, rats, and mice, which are destroyed in the manner from whence is derived its trivial name, the boa, when it attains unusually large dimensions, is also capable of killing deer and large dogs; while it is always ready for such birds as it can capture, and does not disdain, when in captivity, a meal of eggs. The stories of its killing adult human beings and horses are, however, mere fabrications. Nothing is known of the breeding habits of this snake and its kindred in a wild state; but from observations made on specimens in captivity, it appears that the eggs are generally hatched within the body of the parent, although one instance is on record where young and eggs were produced simultane-

ously. To European palates, snakes would probably be highly unacceptable as food, however temptingly they might be dressed; but in Eastern South America, the flesh of the boa is regarded as a most dainty dish, while its fat is reputed to be highly efficacious in the healing of various diseases. The skin is used to ornament saddles and bridles, and for other decorative purposes. None of the other members of the genus attain dimensions equal to those of the common boa, the Malagasy species being the smallest of all.

Keel-Scaled Boa The last representative of the section of the subfamily in which the head is well defined from the neck, and the tail more or less prehensile, is the keel-scaled boa (*Casarea dussumieri*) of Round island, near Mauritius, distinguished as a genus by the keeling of the scales, and the long tail; its other general characteristics being similar to those of the true boas, except that the nasal shields of the head are separated by a pair of internasals. This snake, which attains a length of about four feet, and has a prominent and obliquely truncated muzzle, is either uniform pale brown above, or brown with two dark stripes and a lateral series of small spots down the body, a dark streak on each side of the head through the eye, and the under parts either plain yellow or yellow spotted with black, the under side of the tail always having such spots.

Sand Snakes The snakes of this genus, together with those of three allied genera, which are the remaining members of the family, may be distinguished at a glance from the boas and their allies by the gradual passage of the head into the body without any constriction at the neck; while they are further characterized by the tail being, at most, only slightly prehensile. From their allies, the sand snakes are distinguished by the small scales being either smooth or singly keeled, and by the head being covered with small shields, of which the rostral is enlarged. The eye is small, and sometimes minute, with a vertical pupil; while the body is cylindrical, and the very short tail, which is frequently without any power of prehension, has a single row of shields on its lower surface. These snakes are represented by seven species, with a geographical distribution including Northern and Eastern Africa, and Southern and Central Asia, as well as a part of the extreme southwest of Europe. The best-known species is the Egyptian sand snake (*Eryx jaculus*), which has a length of about two feet, and is an inhabitant of the Ionian islands, Greece, Southwestern and Central Asia, and the north of Africa. In color it is very variable, the upper parts being in some examples pale grayish, reddish, or yellowish brown, ornamented either with dark brown or blackish transverse blotches or alternating spots, while in other cases the general color is brown with pale spots. A dark streak runs from each eye to the angle of the mouth; the under parts are either uniform white, or white with blackish dots, and there is a more or less distinct dark streak along each side of the tail. This species is exceeded in size by the Indian sand snake (*E. johni*), which attains a length of over a yard, and inhabits the plains of Northwestern, Central, and Southern India. This snake is generally banded, but the young may be of a uniform pale coral-red color. Although resembling the boas in being nocturnal, these snakes are quite different in their mode of life, inhabiting open sandy plains, and feeding on small mammals, lizards, and worms. In search of their prey they frequently enter holes and crevices among

rocks, and they will also burrow in the sand. They are perfectly harmless, and generally make no attempt to bite; but they are somewhat unsatisfactory creatures in captivity, owing to their habit of lying concealed among the gravel of their cage. The Indian species is frequently carried about by snake charmers, who are in the habit of mutilating the short tail so as to make it look like a head; whence arises the legend of two-headed snakes. A second Indian species (*E. conicus*) was formerly referred to a separate genus (*Gongylophis*), on account of having a series of keeled scales between the eyes.



EGYPTIAN SAND SNAKE.
(One-half natural size.)

Allied Genera Of the remaining members of the family, *Lichanura*, with one Californian species, differs from the sand snakes by the smaller size of the rostral shield, which is longer than wide; while *Charina*, which is likewise Californian, has the head covered with large shields. On the other hand, *Bolieria*, as represented by a single species from Round island, near Mauritius, differs from all the other members of the group in having three or four keels on the scales, the muzzle being covered with large shields.

In this place may be noticed certain gigantic snakes from the lower and middle Eocene rocks of Europe, described under the name of *Palæophis*, and represented

Extinct
Python-
like
Snakes

by closely-allied, if not generally identical forms in the corresponding strata of North America. Equal in size to those of the largest pythons, the vertebræ differ from the latter by the much greater height of the upper or neural spine, which has not the backwardly-directed process at its summit characterizing the pythons. From the shape of these vertebræ, it is pretty certain that these snakes had compressed bodies like the modern sea snakes, while from the nature of the deposits in which their remains occur, there can be little doubt that they were marine in their habits. Whether they were really allied to the pythons and boas may be doubtful, but in any case it is probable that they indicate a separate family.

THE CYLINDER SNAKES

Family *ILYSIIDÆ*

Agreeing with the pythons and boas in the retention of vestiges of the hind-limbs, the small group of cylinder snakes appears to form a connecting link between the two former and the under-mentioned family of shield-tailed snakes; their essential point of distinction from the preceding being that the supratemporal bone of the skull is of small size, and included in the walls of the brain case, instead of standing out as a support for the quadrate bone, which is much shorter than in the boas and pythons. Teeth are present on the palate as well as in the jaws; and the vestiges of the hind-limb usually take the form of a spur on each side of the vent. In general appearance, and in the arrangement of the scaling, these snakes approximate to the boas; while as regards the structure of the skull they are intermediate between them and the next family. The distribution of the group is remarkable, being restricted to Ceylon and Southeastern Asia in the Eastern, and to tropical America in the Western Hemisphere. Three genera, of which two have one species, while the third has three, represent the family.

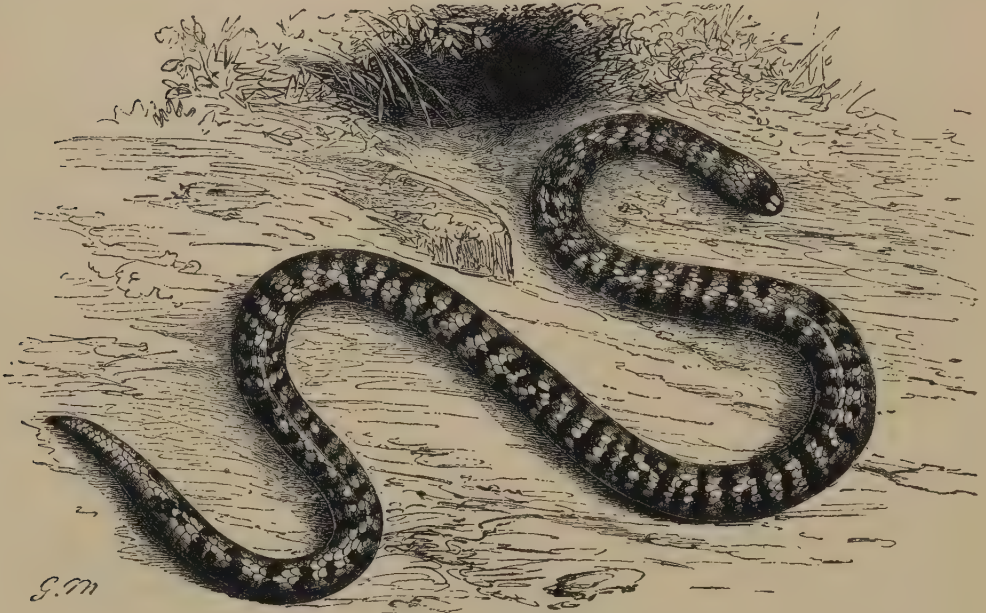
Coral Cylinder
Snake

The single representative of the typical genus of the family is the beautiful coral cylinder snake (*Ilysia scytale*), inhabiting the Guianas and upper Amazonia, and attaining a length of something over two and one-half feet. The distinctive features of the genus are the presence of two teeth in the anterior upper jawbones, or premaxillæ, and the eye being situated in the middle of an ocular shield. The color is a splendid coral red ornamented with black rings, or incomplete ring-like black bands. From the little that is known concerning its habits, it appears that this snake is sluggish in its movements, and never wanders far from its retreat, which is situated under the roots of a tree or in a hole or cleft in the ground. It feeds on insects and blind snakes, and produces living young.

Red Snake

The true cylinder snakes, as typically represented by the red snake (*Cylindrophis rufus*), differ from the preceding by the absence of teeth in the anterior upper jawbones, and likewise by the eye not being included in any of the head shields. This genus has three representatives, and is distributed over

Ceylon and Southeastern Asia to the eastward of the Bay of Bengal; the common red snake ranging from Burma and Cochin-China to the Malayan region. This snake, which attains a length of about two and one-half feet, is either brown or black above, with or without light alternating crossbars; the under parts being either white with black transverse bars or spots, or black with white bands, while the under surface of the tail is of a brilliant vermilion hue. All the snakes of this genus are burrowing reptiles, seldom showing themselves above the surface of the ground, and feeding on insects, worms, and the smaller mammals. In common with their allies, they have the body covered with polished, rounded scales,



CORAL CYLINDER SNAKE.
(One-half natural size.)

which (in conformity with their burrowing habits) are scarcely larger on the upper than on the lower aspect, although becoming wider on the inferior surface of the tail.

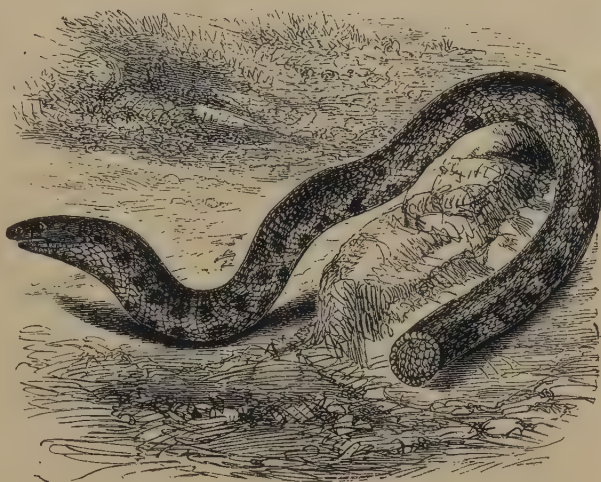
The third genus of the group (*Anomalochilus*), represented by a single species from Sumatra, differs from the preceding in the absence of a groove on the chin.

THE SHIELD TAILS

Family *UROPELTIDÆ*

The snakes of this family, while agreeing with the boas and pythons in the structure of the lower jaw, are sharply distinguished by the loss of all traces of the

limbs, and likewise by the complete disappearance of the supratemporal bone in the skull. By Mr. Boulenger they are regarded as directly descended from the preceding family of the suborder. The skull is remarkable for the firm union of its constituent bones; and although both jaws are toothed, the teeth are small and feeble, and very rarely present on the palate. Externally these snakes are characterized by their cylindrical bodies; short, narrow heads, which pass imperceptibly into the neck; and by the extremely short, truncated, or slightly tapering tail, which generally ends in a rough, naked disc, although in one genus it is covered with keeled scales. On the body the scales are small and polished, those on the lower surface being always somewhat larger than those above; the eye is minute, and the cleft of the mouth comparatively small, and incapable of much dilatation.



A SHIELD-TAILED SNAKE.

These snakes are represented by upward of seven genera, some of which comprise a large number of species, and are restricted to Ceylon and the mountains of Peninsular India. They are purely burrowing creatures, generally living in soft earth, at a depth of several feet, and consequently but seldom seen unless specially searched for. They are frequently dug up in the cultivation of tea and coffee plantations, and may be found beneath logs and stones. On the mountains these earth snakes, as they are frequently called, may be met with in the open grass lands, and during the rainy season they not unfrequently leave their burrows to travel some distance on the surface. Of relatively-small size, many of them are beautifully colored with red and yellow, while those that are black display an iridescence like that of some of the smooth-scaled skinks among the lizards. The food of these reptiles appears to consist solely of earthworms, and the eggs are hatched before quitting the body of the parent. There is a legend current among the natives of India to the effect that every time a cobra bites it loses a joint of its tail, and eventually acquires a head like that of a toad; and Sir J. E. Tennent was of the opinion that this fable was based on the shield-tailed snakes, in which the jaws have lost the great power of dilatation so characteristic of serpents in general.

THE COLUBRINE SNAKES

Family COLUBRIDÆ

The skulls of the remaining snakes are markedly distinguished from those of the foregoing by the total absence in the lower jaw of the bone known as the coronoid; while in all cases a supratemporal is present on the upper surface of the skull. The present family, which includes by far the greater majority of the species of the suborder, and comprises both harmless and noxious kinds, is specially distinguished from those to be mentioned later on by the circumstance that in the skull the upper jawbone, or maxilla, is fixed in a horizontal position, and also that the pterygoids reach either to the quadrate bone or the lower jaw.

Before coming to the Colubrine family it should, however, be mentioned that there is one remarkable snake (*Xenopeltis unicolor*) from Southeastern Asia retaining in the structure of its skull traces of affinities with the boas and pythons. This affinity is displayed by the fact that the prefrontal bone, which lies immediately behind the nasal aperture of each side, is of large size and extends forward and inward to articulate with the nasal bone in the same manner as the boas. Accordingly, this snake is regarded as the representative of a distinct family (*Xenopeltidae*), which is considered to have originated from the *Boidæ* quite independently of the Colubrines.

From *Xenopeltis* the Colubrines are distinguished by the small size of the prefrontal bone of each side, which articulates merely to the outer front angle of the frontal bone without any contact with the nasal bone. In such a large group it is highly important to have some means of division into subgroups of higher value than genera; and, according to the modern classification, three such serial divisions may be indicated by the characteristics of the teeth. The first and most primitive of these series, which may be termed the solid-toothed colubrines (*Aglypha*), is characterized by the whole of the teeth being solid, without any trace of grooves, all its representatives being harmless. On the other hand, in the second series or hind-fanged colubrines (*Opisthoglypha*) one or more of the hinder teeth of the upper jaw are grooved; while in the third series or front-fanged colubrines (*Proteroglypha*) the front teeth of the upper jaw are grooved or tubular. Of the last series the whole of the members are poisonous, while many of those of the second are noxious in a minor degree. All these three sections contain species adapted to particular modes of life, so that we may have two or three snakes which, while externally very similar, are only distantly allied to one another.

Wart Snakes The Javan wart snake (*Acrochordus javanicus*) may be taken as a well-known representative of the first, or acrochordine subfamily of the solid-toothed colubrines, which includes only five genera, distributed over Southeastern Asia and Central America. Unfortunately, the characteristics distinguishing this subfamily from the next are connected with the bones of the skull, and cannot therefore be verified without dissection; but in the study of snakes, according to the modern system, the student must accustom himself to such difficul-

ties. The essential feature of the skull in the present group is the production of the postfrontal bone above the cavity of the eye; while, as a secondary feature, the scales of the body overlap one another but very slightly, if at all. The Javan wart snake, which is the sole representative of the genus, is characterized by the absence of lower shields, by the head being covered with uniform granules, and by the very slight compression of the body. The head is rather short and broad, with the muzzle wider than long, and the small eyes directly forward; while the nostrils are placed close together on the tip of the muzzle. The nearly cylindrical tail is short and prehensile. The color is brown above and yellowish on the sides; the young having large irregular dark brown spots, which coalesce into bands on the back, and gradually tend to disappear in the adult. In size this snake may measure upward



JAVAN WART SNAKE.
(One-eighth natural size.)

of eight feet. It is distributed over the Malay Peninsula, Java, and New Guinea; and, although it has been stated to be terrestrial, modern observations indicate that it is essentially aquatic, seldom even leaving the water, and feeding upon fish and frogs. A female in the possession of Cantor gave birth to twenty-seven young ones in less than half an hour, which were active and bit fiercely as soon as they came into the world.

An allied genus, represented by a single species (*Chersydrus granulatus*), ranging from Southern India to New Guinea, differs by the marked compression of the body and tail, and thus closely resembles the sea snakes of the front-fanged series of the family, and likewise resembles them in habits, frequenting the mouth of rivers and the coast from Southern India to New Guinea, and being often found far

out at sea. It produces living young, and subsists on fish. A third Oriental genus, likewise known merely by one species (*Xenodermus javanicus*), has large shields on the under surface. In the other two genera — *Stoliczkaia* from India, and *Nothopsis* from Central America — not only are there lower shields, but the granules on the head are replaced by large shields.

Water Snakes The large group of water snakes bring us to the second and by far the largest subfamily of the solid-toothed colubrines, which is known as the *Colubrinæ*, and is distinguished from the preceding group by the supratemporal bone not being produced over the region above the socket of the eye; while the scales are usually overlapping, and teeth are present throughout the entire length of the upper and lower jaws. The water snakes belong to a large assemblage of genera of the subfamily characterized by the circumstance that in the skeleton of the backbone inferior projections or spines are present throughout its length, the vertebræ in the hinder region of the body having these spines represented by a more or less well-developed crest or tubercle. From their allies, the water snakes are distinguished by having the hinder upper teeth larger than those in front, the equality in the size of the lower teeth, the rather large size of the eye, in which the pupil is round, the presence of a pair of internasal shields between the nostrils, the regular longitudinal series formed by the scales throughout the body, and by the teeth in each hinder upper jawbone varying in number from eighteen to forty, and forming a continuous series.

Represented by over forty species, the water snakes have an almost cosmopolitan distribution, although they are unknown in South America, while in Africa south of the Sahara they are less abundant than in other regions, and in Australia they occur only in the northern districts. Dr. Günther writes that the typical water snakes "are easily recognized by their stout, cylindrical body, keeled scales, flat head covered with regular shields, wide cleft of the mouth, and numerous teeth, the strongest of which are at the hinder end of the maxillary bone. They frequent the neighborhood of fresh water, and feed on aquatic animals — frogs, toads, and fishes. They do not overpower or kill their prey by throwing a coil of the body round it, but, having seized it, they at once commence to swallow it. They are excellent swimmers, but more frequently live near water than in it, in agreement with which habit, the position of their nostrils is not on the upper surface of the head, as in the true fresh-water snakes, but on the side."

Ringed Snake The best-known and at the same time the typical representative of the group is the common ringed snake (*Tropidonotus natrix*), inhabiting Europe, Algeria, and West and Central Asia, and attaining a maximum length of six and one-half feet. Belonging to a group of the genus in which the number of teeth in the hinder upper jawbone does not exceed thirty, this snake has a single anterior temporal shield on the head, usually seven upper labial shields, of which the third and fourth enter the aperture of the eye, and from one hundred and fifty-seven to one hundred and ninety shields on the lower surface of the body. The eye is of moderate size, and most of the scales are strongly keeled. The color is usually gray, olive, or brown above, with spots or narrow transverse bands; the labial shields being white or yellowish, with their dividing lines black; while the under

parts are mottled black and white or gray. There are, however, several variations as regards the coloration of the neck. In the ordinary variety, for instance, there is a white, yellow, or orange collar, usually divided in the middle, behind which is a broad black collar, the latter being sometimes alone present. In another variety, mostly from the south of Europe, the collar is altogether wanting, or reduced to a small black patch on each side of the nape; while in the southeastern race the collar, although well marked, is divided in the middle, and there is a yellowish streak along each side of the back.

In England the ringed snake is one of the most common reptiles, inhabiting woods, heaths, and hedges, especially where water is abundant. Although its chief food consists of frogs, it also preys upon voles, mice, young birds, and fish, and is stated occasionally to consume eggs. When a frog is pursued by one of



RINGED SNAKE SEIZING ITS PREY.
(One-fifth natural size.)

these snakes it seems paralyzed with fear, and, instead of making any effort to escape, sits still and gives vent to a shrill cry never heard at any other time. Generally the frog is seized by the hind-leg, and gradually swallowed by the snake without its position being changed. On this point Bell observes that "when a frog is in the progress of being swallowed in this manner, as soon as the snake's jaws have reached the body, the other hind-leg becomes turned forward, and as the body gradually disappears, the three legs and head are seen standing forward out of the snake's mouth in a very singular manner. Should the snake, however, have taken the frog by the middle of the body, it invariably turns it by several movements of the jaws, until the head is directed toward the throat of the snake, and it is then

swallowed head-foremost." As a rule, the frog remains alive during the swallowing process, and it may sometimes be heard to croak when buried in the stomach of its captor, while instances are on record where a frog has returned after being thus entombed. When swimming, the ringed snake carries its head and neck raised above the surface of the water. The skin, as in the case of other serpents, is shed several times during the year, and is drawn off turned inside out, so that the lenses covering the eye appear concave instead of convex. Previous to changing its coat, the reptile becomes almost if not completely blind, and evidently ill at ease, and the change



VIPERINE AND TESSELATED SNAKES.
(Two-fifths natural size.)

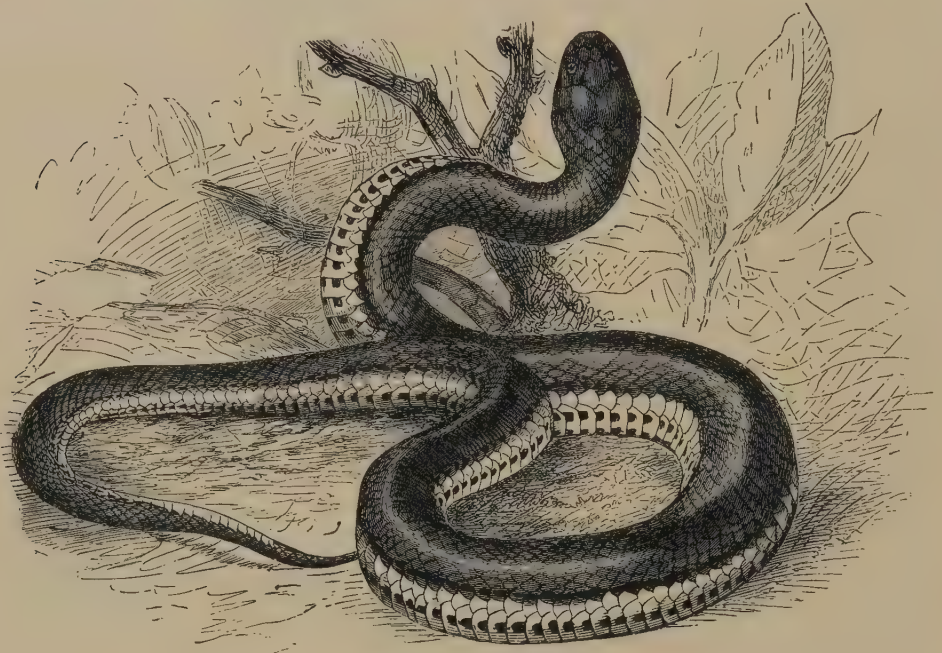
is accomplished by the old skin bursting at the neck, and being pulled off by the owner wriggling its body between brushwood or dense herbage. Some sixteen to twenty eggs are annually deposited by the female of the ringed snake, these being attached together by a viscid substance. Although they are sometimes hatched solely by the heat of the sun, at other times the process of development is hastened by their being placed in a heap of decaying vegetable matter or manure. When the cold of autumn makes itself felt, this species retires for the winter, passing its time in a state of torpor ensconced in some hole in a hedge bank, under the roots of

trees, or some such place, where it remains till awakened by the returning warmth of spring. Not unfrequently several snakes occupy the same hole for the winter, and occasionally a considerable number have been found coiled up together in a mass.

Tesselated and Viperine Snakes The preceding species, as already said, belongs to the typical section of the genus, in which the teeth of the hinder upper jawbone do not exceed thirty in number, and are gradually enlarged toward the hinder end of the series, while the eyes and nostrils are lateral, and the internasal shields broadly truncated in front. As examples of the second section, in which, while the number and characteristics of the teeth are similar, the small eyes and nostrils are directed upward and outward, and the internasal shields usually much narrowed in front, we select the tesselated snake (*T. tesselatus*) and the nearly-allied viperine snake (*T. viperinus*), both of which are found in Europe, the former being a more southerly type than the latter, and extending eastward into Southwestern and Central Asia. The tesselated snake, which never grows quite so large as the common ringed species, is olive or olive gray above, and may be either uniformly colored, or marked with dark spots, usually arranged quincuncially, on the back. The nape of the neck is ornamented with a dark chevron; the upper labial shields are yellowish, with dark lines of division between them; and the under parts are either yellow or red mottled and marbled with black, or almost wholly black. The viperine snake is rather smaller, having the upper surface gray, brown, or reddish, with a zigzag black band down the back, and a row of yellow-centred black spots down each side. There is a more or less distinctly-marked oblique dark band on each side of the top of the head, and another on the nape of the neck; while the labials and under parts are colored like those of the tesselated snake. The general habits of both these species are very similar to those of the ringed snake; but in the spring they are more generally found concealed in pairs beneath stones, and only take to the water in the summer. As other well-known North-American representatives of the genus, we may refer to the garter snake (*T. ordinatus*) and moccasin snake (*T. fasciatus*), the former belonging to the first, and the latter to the second section. As an example of the third section, in which the last two or third upper teeth are suddenly enlarged, the Indian long-banded snake may be mentioned.

Oblique-Eyed Snake Among the genera belonging to this section the only other that our space admits of even mentioning is the one containing the numerous species of oblique-eyed snakes. Generally having a smaller eye than the water snakes, the members of this genus are distinguished by having only a single internasal shield; the nostril being placed in a half-divided nasal shield, while the teeth of the lower jaw are of nearly equal size, and the scales lack the pits characterizing those of an allied genus. There are from eighteen to twenty-five teeth in the hinder upper jawbone; the head is, at most, but slightly distinct from the neck; the body is cylindrical; and the tail, which has two rows of shields beneath, is of moderate length, the scales being usually striated and keeled. The genus is represented by eleven species, some of which are found in the New World, while others inhabit Southeastern Asia, and others tropical Africa.

The keel-tailed snake (*Helicops carinicauda*) inhabits Brazil. It attains a length of between three and four feet, and is characterized by having the scales on the back of the head smooth, and those on the body keeled and arranged in nineteen rows, the frontal shields being nearly or quite as long as the parietals, while there are from one hundred and twenty-six to one hundred and fifty-five shields on the lower surface of the body. The general color is dark olive brown above, with four more or less distinctly-defined blackish stripes, and a yellow stripe along the two lower rows of scales; on the under parts the ground color is yellow or red, with black spots or stripes on the body, and a black stripe on the tail. In the neighborhood of the Rio Grande do Sul this species is one of the commonest of snakes; and while its general habits appear to be very similar to those of the water snakes, like all the other members of its genus, it produces living young.

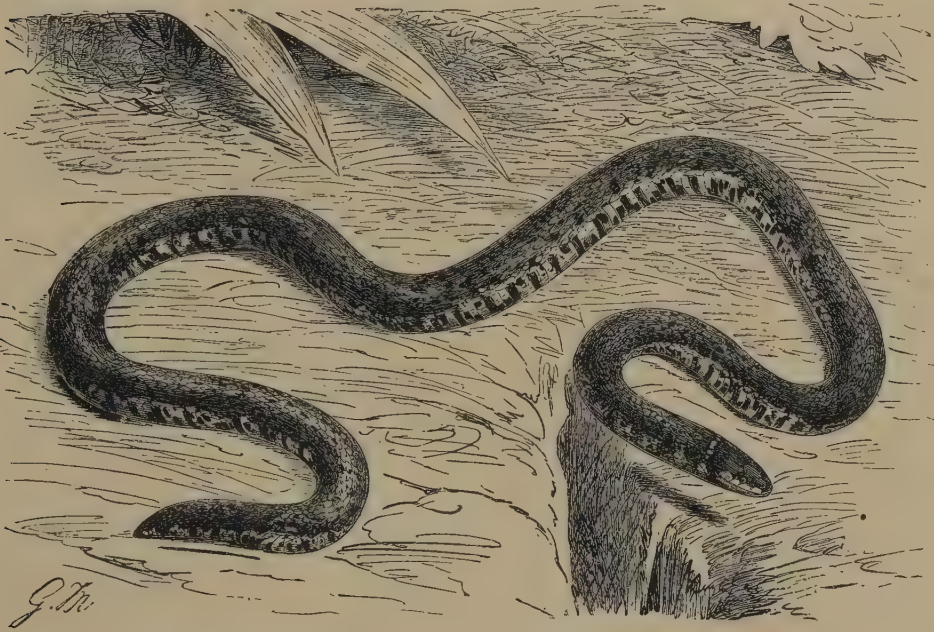


KEEL-TAILED SNAKE.
(One-half natural size.)

The snakes we have now to consider, while still belonging to the **Pygmy Snakes** typical subfamily of the solid-toothed series, differ from the foregoing in that inferior spines are developed only in the vertebræ of the anterior half of the backbone, and are further characterized by the nasal bones being fully as large as the prefrontals. The preceding group are more or less aquatic in their habits, but those of the present assemblage are terrestrial or arboreal. The pygmy snakes have the hinder borders of the shields on the lower surface of the body entire, the front lower teeth larger than the hinder ones, the eyes relatively small, and no internasal or temporal shields on the head. The head is not distinct from the neck, each nostril is pierced in a very small nasal shield, the body is cylindrical with the smooth

scales arranged in thirteen rows, and there are two rows of shields on the lower aspect of the tail.

These snakes are represented by some thirty species, their headquarters being the islands of Java, Sumatra, and Borneo. The figured species (*Calamaria linnæi*) is from Java. They are all of small size, frequently not exceeding a foot in length; and they are in the habit of hiding themselves among stones, beneath fallen tree-trunks, or in grass. Their small dimensions, together with the relatively narrow cleft of the mouth, and a want of dilatibility in the throat and body, indicate that they do not prey upon other reptiles. Gentle and harmless themselves, these snakes are often attacked and killed by crabs and other venomous members of their own tribe.



JAVAN PYGMY SNAKE.
(Natural size.)

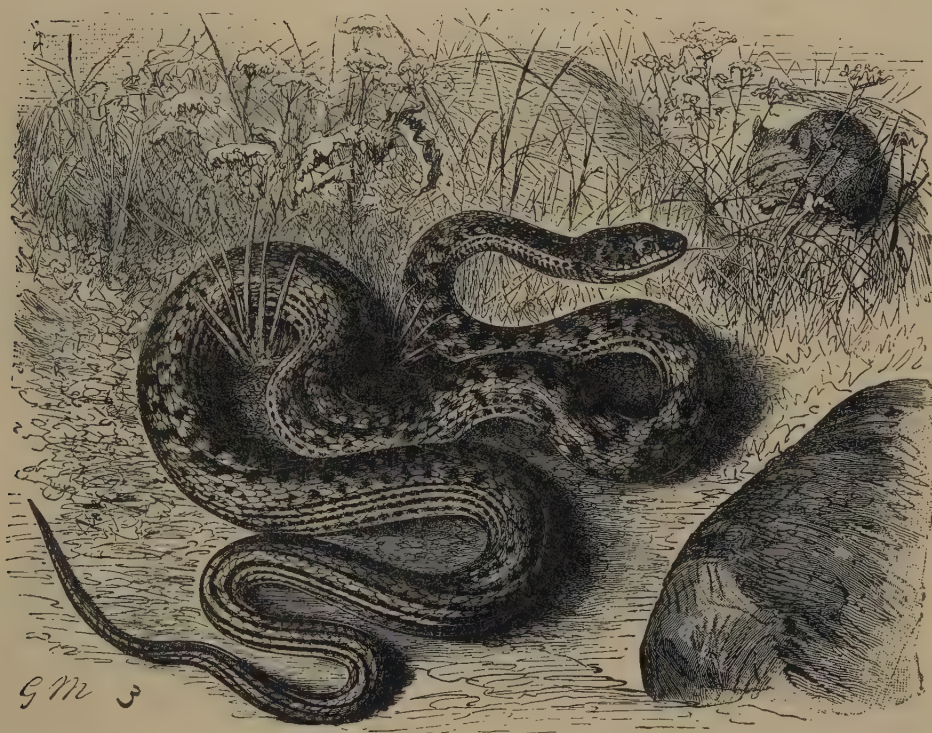
Sling Snakes On account of the well-known European smooth snake (*Coronella* *lævis*) being included among them, we mention as a second genus of this group the sling snakes, of which there are about twenty known species ranging over Europe, Western Asia, Africa, and America, while one (*C. brachyura*) occurs in India. They belong to a group of genera in which the whole of the lower teeth are nearly equal in length; while they are specially distinguished by the presence of from twelve to twenty teeth in the hinder upper jawbone, which increase in size toward the back of the series. The head is short, and scarcely distinct from the neck; the eye being rather small, with a round pupil, and the head shields normal. The body is cylindrical, and covered with smooth scales arranged in from fifteen to twenty-five rows, and furnished with pits at their tips; the tail is of moderate length;

and whereas the shields on the inferior aspect of the body are rounded, those beneath the tail are arranged in a double series.

The smooth snake, which attains a length of about twenty-five inches, is very variable in coloration, but the ground color of the upper parts is generally brown. The most distinctive features are a large dark spot on the neck, often extending into a stripe, and two rows of dark brown spots arranged in pairs, and running down the body; there is also a dark stripe passing through the eye and the side of the neck, while the under parts are either steely blue, or reddish yellow and white, in some cases spotted with black. This snake is found over the greater part of Europe, and is occasionally met with in some of the southern counties of England. Although now and then found in damp or swampy localities, it frequents dry stony places where there is plenty of sunshine, resorting sometimes to old stone bridges and heaps of building material. Like its congeners, this snake is chiefly terrestrial in its habits; in disposition it is fierce, and its prey consists of other snakes and lizards. In the end of August or beginning of September the smooth snake lays from three to thirteen eggs, which are so far developed that the included young almost immediately break the shells and escape.

Nearly allied to the preceding are the ophidians which (from their German name *zornschlangen*) we may term fierce snakes; these demanding special notice on account of their having several representatives in Southern Europe. From the preceding genus they may be distinguished by the more slender form of the body, and the presence on the head of one or more suboculars below the preocular shield; while the arrangement of the longitudinal rows of scales in odd numbers differentiates them from an allied genus. The number of teeth in the hinder upper jawbone varies from twelve to twenty; the head is long and distinct from the neck, with the eye of moderate size or large, and its pupil round. The body is elongated and cylindrical, with the smooth or slightly keeled and pitted scales arranged in from fifteen to thirty-one rows. On the lower surface of the body the shields are rounded, or obtusely keeled on the sides, and the long tail has two inferior rows of shields. The fierce snakes are represented by some twenty species, ranging over Europe, Asia, and Northern Africa, several of them occurring on the Continent, although none are met with in the British Islands. Their headquarters may be considered to be the countries surrounding the Mediterranean basin. Deriving their name from the fierce and bold demeanor of the majority of their representatives, these snakes are terrestrial or partially arboreal in their habits, and feed chiefly on small mammals and birds. Of the European forms, a well-known example is the dark green snake (*Zamensis gemonensis*), inhabiting Hungary and the Mediterranean countries, and extending as far north as the south of Switzerland; in the east it is represented by a variety known as the Balkan snake, which attains a larger size than the typical form. These snakes are distinguished from their allies by the regular arrangement of the shields on the head, and the presence of two preorbital shields, of which the lower is small and placed in the line of the labials; and they are further characterized by the relative shortness of the tail, which scarcely reaches a fourth of the total length. The smooth scales are arranged in from seventeen to nineteen rows. The ordinary form may attain a length

of about four feet, but is generally smaller. In ground color the head and nape are grayish yellow, the back and tail greenish, and the under parts yellow, upon them being black markings, which, while irregular above, form regular oblique bars inferiorly, and in the hinder part of the body are arranged in longitudinal stripes which continue to the end of the tail. In some specimens, however, the ground color of the upper parts is a beautiful yellowish green, while on the lower surface it is canary yellow; in a third variety the whole upper surface is uniform olive brown, and in some cases it is completely black, the under surface of the body being gray, with a steely-blue lustre on the sides and the whole of the under parts. This



THE DARK GREEN SNAKE.
(One-fourth natural size.)

snake is very abundant in Italy, and may be met with in most gardens in the neighborhood of Rome. Its habits vary to a certain extent according to locality; while in the Russian steppes it frequents the hottest and driest spots, in Dalmatia and the Tyrol it is found in sunny, although by no means dry situations, either in woods or among old buildings.

The other European species is the horseshoe snake (*Z. hippocrepis*), common both to Southern Europe and Northern Africa, and represented in the lower figure of the illustration on p. 2570. From its allies it is distinguished by the presence of a series of small suborbital shields

Horseshoe
Snake

beneath the eye, which completely separate it from the upper labials, by the divided anal shields, the presence of from twenty-five to twenty-nine longitudinal rows of scales on the body, and likewise by the constancy of the coloration. Measuring nearly six feet in length, this handsome snake has the ground color of the upper parts varying from greenish or grayish yellow through orange to reddish brown. As a rule, the head is marked by a dark oblique band between the eyes, behind which is a second band, convex in front, and reaching to the neck, and a third marked with light spots, so that a horseshoe pattern is formed between the spots and bands. On the back runs a row of yellow-edged dark oval patches, which tend to unite toward the hinder extremity, and on each side of this are a series of smaller



BLACK-MARKED AND HORSESHOE SNAKES.
(One-fourth natural size.)

spots, beneath which, again, are more upright dark marks, extending downward to the lower surface. As the upper dark patches are very large, the ground color is generally reduced to a series of rings, forming a very regular and pretty pattern. The under parts are yellow or orange red, spotted with black.

Here also must be mentioned the Indian rat snake (*Z. mucosus*),
Rat Snake now included in this genus, although formerly referred to the next. It is a large species, attaining a length of six feet or more. In color it is brown above, frequently with more or less distinctly defined black cross bands on the hinder part of the body and tail; the under surface being yellowish, often with black edges to the shields of the hinder part of the body and tail. The range of this well-

known species extends from India to Java. Common everywhere in India, and feeding on mammals, birds, and frogs, the rat snake derives its name from its habit of entering houses in search of rats and mice. Like its allies, it is fierce and always ready to bite, and old specimens taken to Europe never become tame. When irritated, it utters a peculiar sound, which has been compared to that produced by gently striking a tuning fork. A smaller allied Indian species (*Z. corrus*) differs by having the scales arranged in fifteen, instead of seventeen rows.

Running Snakes Nearly allied to the preceding are the American running snakes, of which the pantherine snake (*Ptyas pantherinus*) is a familiar and handsome example. From the last genus the running snakes are chiefly distinguished by their teeth and the larger size of their eyes. They are all large and powerful reptiles, with cylindrical body, clearly-defined head, large eyes, regularly tapering tail, which is at least equal to a fourth of the total length, the scales smooth and arranged in from fifteen to seventeen rows, normally-arranged head shields, unkeeled inferior shields, and about twenty-one equal-sized teeth in the hinder upper jawbone. The pantherine snake, which is an inhabitant of the hottest regions of the Guianas and Eastern Brazil, and is especially common in the neighborhood of Rio de Janeiro, is characterized by having fifteen rows of scales on the body, the lack of the small lower preorbital shield, and its general form and coloration; its length being as much as seven feet. The ground color is yellowish gray on the upper parts; on the front of the head are three dark crossbars, while two broad longitudinal stripes run along the hinder part of the head and neck; the ornamentation of the back takes the form of a row of large grayish-brown black-edged spots, which are lozenge shaped on the neck, but further back become irregular, and confluent with two lateral rows of spots. The yellowish-white shields of the edges of the jaws have black lines of division, and behind each eye a blackish-brown streak runs to the angle of the mouth. This snake frequents swampy situations well covered with trees and bushes, and is remarkably swift and active in its movements. In its general habits it appears to resemble the ringed snake, feeding almost entirely on frogs and fish.

Climbing Snakes The typical representatives of the family are the climbing snakes, of which there are a large number of species, distributed over the greater part of Europe, Asia, and North and tropical America. Agreeing with the preceding genus in having the teeth in the hinder upper jawbone of nearly equal size, the climbing snakes have from twelve to twenty-two of these teeth, the teeth of the lower jaw being likewise subequal; and they are further specially distinguished by having the scales of the body arranged in from fifteen to thirty-five longitudinal rows, and furnished pits at their extremities, those in the middle line of the back not being larger than the others. The long head is well defined from the neck, with a moderate-sized eye, of which the pupil is circular, and the shields normally arranged; the elongated body is slightly compressed, with its scales either smooth or keeled; and whereas the shields on the lower surface of the body usually have a more or less well-marked keel on the side, those of the tail are arranged in a double row. All these snakes are fierce in their disposition, and while all can climb well, some are almost entirely arboreal; others again, frequent the neighbor-

hood of water, and are good swimmers. The food of all consists of small mammals and birds. Formerly the chain snake (*Coronella getula*) of the United States, common in the neighborhood of New York, and attaining a length of about five feet, was included in this genus, but is now referred to *Coronella*. The dark ground color, which varies in tint from reddish brown to blackish brown and even black,



ÆSCULAPIAN SNAKE.
(One-half natural size.)

shows on the upper surface a number of yellow cross bands, which on the lower part of the sides unite with similar longitudinal stripes, and thus form a regular light-colored chain extending to the very tip of the tail. The shields on the top of the head are deep chocolate brown, with a few yellow spots; the labial shields are dusky or yellowish white, bordered with blackish brown, and the under parts dirty yellowish white marbled with brown.

Among the European representatives of the genus, the yellow, or Æsculapian snake (*Coluber longissimus*) is recognized by the small head, imperfectly distinguished from the neck, and rounded at the muzzle, as well as by the stout body, rounded tail, and the nature of the scaling. On the head there is no small preorbital shield, and of the eight upper labials the fourth and fifth enter the circle of the eye; the body has from twenty-one to twenty-three rows of smooth scales, and the anal shield is divided. Generally, the upper surface is brownish yellow, with a tinge of gray, and the lower aspect whitish, the hinder part of the head having a yellow spot, while the back and sides are marked with small whitish dots, which in some places are very distinctly defined, and assume the form of the letter X. There is, however, great individual variation in color, and a dark and a light variety may be recognized. In the south of Europe, where it attains a length of about four



LEOPARD SNAKE.

feet, this snake prefers rocky, or at least stony districts abundantly covered with bushes; but in Schlangenbad, the only German locality where it is found in any numbers, old walls are its favorite resorts. As it feeds chiefly on voles and mice, it is a decided benefactor to the agriculturist and gardener. It also consumes, however, a certain number of lizards, as well as such birds as it can contrive to capture, and occasionally plunders a nest and sucks the eggs. It is very fond of climbing bushes, and low boughs or stumps of trees, as represented in our illustration; and in thick forests will go from bough to bough, and then from tree to tree without descending to the ground. Indeed, it is such an adept in climbing, that it frequently captures swift-running lizards on the stems of trees.

Another South European species is the four-lined, or leopard snake (*C. leopardinus*). Remarkable for the beauty of its coloration, which, however, is subject to

great individual variation, this snake attains a length of about a yard, and differs from all its congeners in the absence of a lower preocular shield on the head, and the presence of eight upper labial shields, of which the fourth and fifth enter the circle of the eye. There are from twenty-five to twenty-seven longitudinal rows of scales in the thickest part of the body, and the anal shield is divided. Of the numerous variations, there are two which are most constant, the first being the typical but rare four-lined race. In this form the ground color is brownish gray, upon which are usually four black longitudinal stripes, here and there interrupted, although these are sometimes replaced by two dark or blood-red lines. On the sides are small blackish spots; the under surface of the head and fore part of the body is



FOUR-RAYED SNAKE.
(One-fourth natural size.)

either yellowish white or bright yellow, but each under shield is marked with four or five irregular blackish spots, which become so large posteriorly that the whole surface appears steel blue, the yellow only showing on the edges of the shields. In the second variety, or leopard snake, the ground color is mahogany red, mottled on the upper surface with blood-red black-edged spots, which may either be arranged in two rows, or coalesce into transverse bands; on each side there is a row of smaller, blackish, crescentic spots alternating with those of the back. The range of this species is bounded to the west by the mountains of Southern Italy and Sicily, and to the east by Asia; both varieties occurring together in most districts between these limits, although in Greece and Dalmatia only the leopard snake is known.

Among the largest of European ophidians is the four-rayed snake (*C. quatuor-radiatus*), which attains a length of between six and seven feet, and is of an olive-brown or flesh-colored hue above, often marked with a pair of longitudinal blackish-brown stripes, a black line running from the eye to the mouth, and the under parts being straw yellow. There are, however, many variations from this typical coloration, some specimens being entirely black, while the young generally have black cross bands on the head, three rows of large brown spots on the back, the sides likewise spotted, and the under parts with a blackish steel-gray tinge. The distinctive specific characteristics are the presence of a small preorbital shield on the head; the arrangement of the scales of the middle of the body in from twenty-three to twenty-five longitudinal rows—these scales being smooth in the young but strongly keeled in the adult—and the divided anal shield. The distributional area of this snake includes the whole of Southern and Southeastern Europe, from Lower Italy and Dalmatia to Turkey, as well as Greece and the adjacent islands, and extends to the interior of Asia Minor, but there is some doubt whether the species occurs in the Caucasian region. All observers are in accord that the four-rayed snake is not only harmless but useful, since it destroys rats, mice, voles, and smaller snakes. It also preys upon moles, lizards, and small birds.

Another European species of the family is the black-marked snake (*Coluber scalaris*), which belongs to a separate group characterized by the following features: The rostral shield of the head is of a large size, convex, and pointed in front, while it extends backward between the prefrontal shields, where it terminates in a point. The tail is relatively shorter than in the typical group. The black-marked snake, formerly separated as *Rhinechis*, and represented in the upper figure of the illustration on p. 2570 has the cylindrical body relatively thick, the tail short and blunted, and the flattened head broad behind and sharp in front. The body scales, which are arranged in from twenty-five to twenty-nine rows, are long, four sided, and smooth; the shields on the under surface of the body are bent at the edges, and those beneath the tail form a double series. As regards color, there is much variation, the ground color varying from bright gray or greenish gray, through reddish or yellowish brown, to olive or reddish yellow; while the markings of the head often take the form of a perpendicular black streak through the eye, and another from the eye to the mouth, the neck having a dark cross band, and a row of similar spots running down the back, beneath which are another series of smaller ones, followed inferiorly by a third and fourth row. With age these spots tend gradually to disappear, till finally there remain only two dark brown or blackish rows running from the neck to the tip of the tail. In length this snake measures rather more than four feet. Everywhere rare, the black-marked snake seems to be confined to Spain and the opposite parts of Africa. While resembling the climbing snakes in the general nature of its food, it also preys upon grasshoppers; and it will follow voles and mice into their burrows. A good climber, it is stated to be more rapid in its movements than any other of the European snakes, and its keenness of vision is remarkable.

Whereas the preceding members of the family only climb trees in search of food the American wood snakes are purely arboreal forms, especially adapted by

their coloration to such a mode of life. Although they resemble the Wood Snakes climbing snakes in possessing equal-sized solid teeth, they differ in the larger eye, which may be of very great size, their distinctly compressed and more slender body, and the small number of its longitudinal rows of scales, which does not exceed from ten to twelve. The five known species are inhabitants of the West Indies and the forest districts of Central and South America, all being characterized by their more or less uniform olive-green coloration. In the forests of Brazil, the Guianas and Venezuela, as well as in the Lesser Antilles, lives the sipo or Brazilian wood snake (*Herpetodryas carinatus*), which we select as a well-known example of



SIPO OR BRAZILIAN WOOD SNAKE.
(One-fourth natural size.)

the genus. Frequently attaining a length of about seven feet, and remarkably beautiful in coloration, this snake generally has the upper parts of a bright verditer or olive green, shot with a tinge of brown on the back, while the under parts are greenish or bright yellow, the greenish hue prevailing in the middle of the body, and the yellow elsewhere. Throughout there is a shimmering play of colors of all shades of green passing into metallic brown, while the middle line of the back has a brighter longitudinal streak, frequently bordered on each side by a darker band. In the West Indies this species undergoes a remarkable change of hue, becoming blackish brown or black above, with the under parts steel gray, the upper

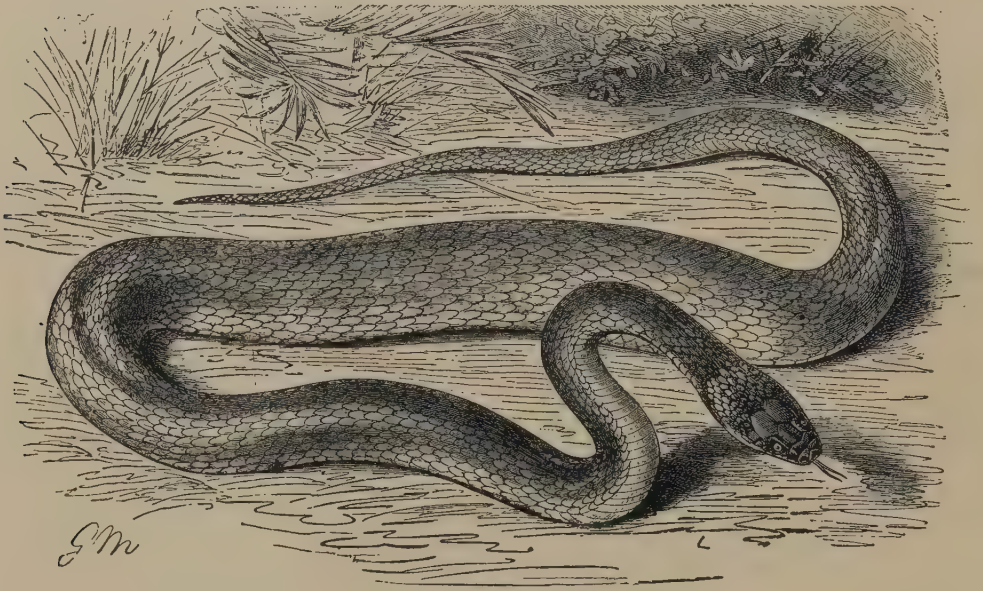
lip and edges of the jaws alone preserving the original yellowish green. The scales are arranged in twelve rows, and are mostly smooth, although the two middle rows on the back are keeled, the eye being of very large size. Next to the coral snake, the sipo is the most abundant of Brazilian ophidians, and may be met with both on sandy jungle-clad ground close to the shore at Rio de Janeiro and Cape Frio, where specimens of upward of ten feet in length have been observed. In addition to sandy localities it also frequents swampy spots near the sea. In its movements it is so rapid that, when startled, it seems to disappear like a flash of lightning. It feeds largely upon frogs, as well as upon lizards and young birds, and lays only five eggs, which are remarkable for their cylindrical and slender form.

Tree Snakes In the Old World and Australia the wood snakes are replaced by the solid-toothed tree snakes, forming the genera *Dendrophis* and *Dendrelaphis*, both of which are distinguished from all the preceding types by having the hinder border of each of the shields on the lower surface of the body with a notch on each side, corresponding to a suture-like lateral keel; the scales of the body being arranged in from thirteen to fifteen rows. While in the first named of the two genera all the teeth in the hinder upper jawbone are approximately equal in length, and the row of scales in the middle line of the back larger than the others, in the second genus the foremost teeth in the hinder upper jawbone are enlarged, but the middle row of scales on the back are similar to the rest. All these snakes have large eyes, and elongated and often compressed bodies, and their general coloration is some shade of green or olive, often with a bronzy tinge; their habits being mostly arboreal. Of *Dendrophis* nine species are known ranging from India to Australia, while *Dendrelaphis* is represented by five species ranging from India and the Malayan region to the Philippines.

Egg-Eating Snake The last representative of the solid-toothed series of the Colubrines that we have space to mention is the curious little egg-eating snake (*Dasypheltis scabra*) of South Africa which represents a subfamily (*Dasypheltinæ*) by itself. The essential characteristic of the subfamily is the rudimental condition of the dentition, the front of both the lower jaw and upper jaw being devoid of teeth. To compensate for this lack of ordinary teeth, the egg-eating snake is, however, provided with a series of about thirty of what may be termed throat teeth, these being the lower spines of the vertebræ, which project into the œsophagus, and are tipped with enamel. The scales are strongly keeled. This little snake is about a couple of feet in length, and has a body not much thicker than a man's finger. Although it lives in trees, and feeds on the eggs of small birds, it will when pressed by hunger descend to the ground and rob hens' nests. That such a tiny creature should be able to swallow a hen's egg seems incredible, but nevertheless a specimen has been taken with the egg actually within its jaws, and the whole head so swollen as to render the mouth incapable of being closed; while an example in the London Zoological Gardens swallowed pigeons' eggs without any apparent difficulty. When swallowed, the egg is split longitudinally by the row of teeth in the throat, and the whole of the contents secured. After being thus broken, the two halves of the shell, generally fitted into one another, are rejected.

Moon Snakes The pale snakes, or, as they are called in Brazil, the moon snakes, may be taken as our first representatives of the second of this three great parallel series into which the Colubrine family is divided. This back-fanged series, or *Opisthoglossa*, is characterized by having one or more pairs of the hinder upper teeth longitudinally grooved, and thus capable of acting as poison fangs. Many of these snakes are indeed extremely venomous, their bite being capable of producing death in a few minutes. They are divided into two subfamilies, of which the first, or *Dipsadinæ*, are characterized by the lateral position of the nostrils; and they are either terrestrial or arboreal in their habits, while their distribution is world wide.

Belonging to the first of the two subfamilies, the moon snakes are characterized by the slender and somewhat compressed form of the body; the flattened head,



CROWNED MOON SNAKE.
(Two-thirds natural size.)

which is but imperfectly differentiated from the neck, is broad behind and narrow in front, although somewhat pointed at the muzzle; the upper jaw projects considerably over the lower. The scales, moreover, are smooth; both the anal shield, and the shields on the lower surface of the tail are single; and the eye, as in most of the other members of the subfamily, has the pupil vertical. The few representatives of the moon snakes are confined to South America, the species here figured (*Scytale coronatum*) being an inhabitant of the eastern side of that continent. In size this snake is comparatively small, measuring only about two feet in length; its distinctive characteristic being that on the hinder portion of the body, or anterior part of the tail, the middle row of scales are not greatly enlarged. In young individuals the ground color is red, with a dark brown circular spot on the back of the head,

another on the crown, and a ring on the neck, behind which are smaller spots of the same color. With age the color darkens, and the markings disappear, till in the adult the upper surface is black, and the lower side white. Very common in the neighborhood of Bahia, this snake, like the other members of the subfamily, is almost exclusively nocturnal; and its food consists solely of lizards. Although their fangs are large, it appears that these reptiles never attack human beings.

Cat Snake

As one of the few European representatives of the group under consideration, reference may be made to the so-called cat snake (*Tarbophis vivax*), which is the sole member of its genus. It is characterized by its spindle-shaped body, the clear distinction between the flattened head and the neck,



CAT SNAKE.
(One-half natural size.)

the relatively-short tail, and the small size of the eyes. In place of a lower preocular shield, the elongated loreal extends backward to the eye, so as to come in contact with the upper preocular, this arrangement being unknown in any other European snake. In the lower jaw the front teeth are much longer and more bent than those which follow; while the fangs in the hinder part of the upper jaw are also elongated and much curved. Sometimes reaching a little over a yard in length this snake is of a dirty brownish yellow or gray ground color, with small black dots; and a chestnut-brown spot on the shields of the head; the neck has a large blackish or reddish-brown patch, and rows of smaller spots of the same color ornament the back. There is also a dark band from the eye to the corner of the mouth; each side of the body has a row of small spots; and the under parts are whitish with a brown

marbling. The cat snake ranges from the shores of the Adriatic to the neighborhood of the Black and Caspian seas, and Africa as far south as 45° N. It inhabits rocky and sunny spots, and feeds mainly if not exclusively on lizards. Although slower than the water snakes, its movements are more rapid than those of the vipers. The virulence of its poison is shown by the circumstance that a lizard bitten by one of these snakes died in a minute and a half.

The tropical regions of the Old World are the home of the typical Nocturnal Tree Snakes genus (*Dipsas*) of the subfamily, which is characterized by the long and compressed body and tail, the sharp distinction of the head from the neck, the moderate or large size of the eye, with its vertical pupil, and the normal arrangement of the shields on the head, in which the hinder nasal is more or less markedly hollowed. The number of teeth in the hinder upper jawbone varies from ten to twelve, the two or three hinder pair being elongated and grooved, while in the lower jaw the front teeth are the largest. The scales on the body are arranged in from seventeen to twenty-seven longitudinal rows, those of the middle row of the back being larger than the rest; and the medium-sized or long tail has its inferior shields in two rows. These snakes are represented by about twenty species, inhabiting Southern Asia, New Guinea, Northern Asia, and Africa. The majority are inhabitants of forests or scrub jungle, and are almost entirely arboreal; but a few are terrestrial, and frequent open country. Many of these snakes attain a length of six or seven feet, and their prevalent ground colors are brown and black. The Indian forms at least are purely nocturnal, and their food consists of mammals, birds, and, more rarely, lizards, and occasionally birds' eggs. It is noteworthy that some species prey entirely on mammals, while others confine their attention to birds. Eight species of the genus are recorded from India, Ceylon, and Burma, while a well-known Malayan form is the ularburong (*Dipsas dendrophila*).

These snakes are represented by two important genera, of which Back-Fanged Tree Snakes *Philodryas* is mainly characteristic of the tropical parts of America, although it also occurs in the West Indies and Madagascar; while the whip snakes (*Dryophis*) are confined to India and the Malay countries. In the American genus the hinder fangs are not very large, being not double the height of the solid teeth in front of them. The body and tail are elongated and more or less compressed, the eyes large, and the smooth or keeled scales arranged in from seventeen to twenty-one rows; while the prevailing color is green. The genus is represented by some fifteen species, among which the green snake (*P. viridissimus*) is a well-known form. This species attains a length of nearly three feet, and has upward of two hundred shields on the lower surface of the body.

In the Indian whip snakes the teeth in the posterior upper jawbone vary in number from twelve to fifteen, one or two near the middle being much enlarged and fang-like. After these comes an interval devoid of teeth, and at the hinder end of the jaw the last two teeth are grooved. In the lower jaw the third or fourth tooth is enlarged and fang-like, those in the hinder part of the series being small and uniform. The head is long, and markedly distinct from the neck, and the eye rather small, with a horizontal pupil. The scales investing the elongated and compressed body are smooth and without pits, and arranged in fifteen oblique rows, those down

the middle of the back being slightly enlarged. The shields on the under surface of the body are rounded, and those beneath the tail form two rows. Deriving their name of whip snakes from the extreme elongation and slenderness of the body and tail these serpents move awkwardly enough on a flat surface, although when coiling and climbing among the branches of trees their rapid movements are graceful in the extreme. While retaining their hold by means of a few coils of the tail thrown round a branch, the length of their body enables them with ease to reach another at a considerable distance, or to dart forth their head in order to seize any hapless bird or lizard that may be within striking distance.

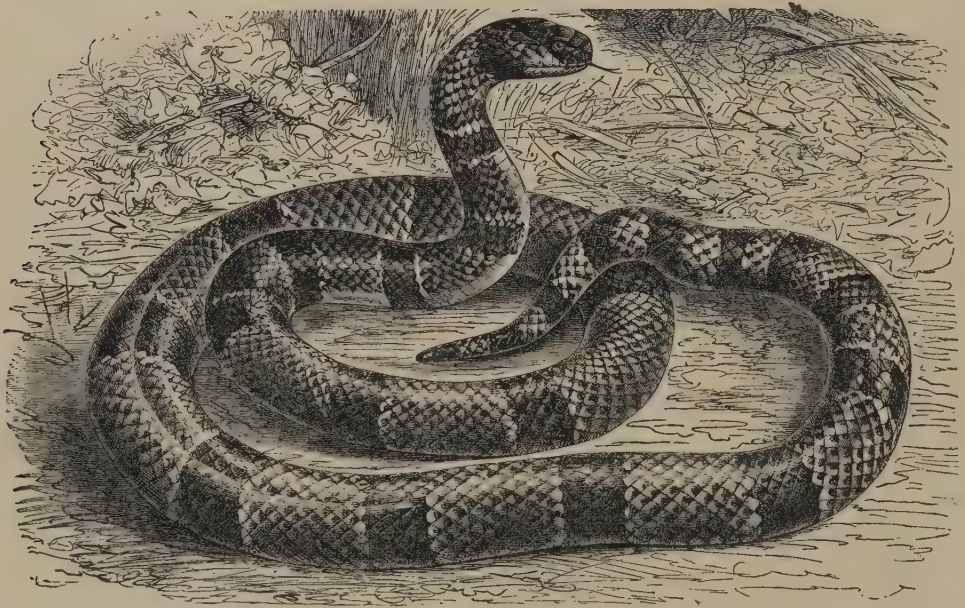
Sharp-Nosed Snakes Nearly allied to the preceding are the sharp-nosed snakes (*Oxybelis*), of which seven species inhabit Central and South America, while the eighth is found in Central and Western Africa. These have small heads, with the snout narrow and elongated, and the rostral shield projecting considerably beyond the lower jaw. The neck is thin and slender, the body greatly elongated and laterally compressed, and the long and thin tail tapering to a fine point. The upper jaw carries seventeen solid teeth of nearly equal size, and four large fangs. In appearance and habits these snakes closely resemble the whip snakes.

Oriental Fresh-Water Snakes Brief reference must be made here to a group of nine genera of aquatic snakes from India, Burma, China, New Guinea, North Australia, and the adjacent countries, which constitute a second subfamily (*Homalopsinæ*) in the hind-fanged series. From the preceding subfamily they may be readily distinguished by the position of the nostrils on the upper surface of the muzzle, while they are further differentiated by their thoroughly aquatic habits. It will be unnecessary to particularize the various genera; but it may be mentioned that the typical genus, *Homalopsis*, belongs to a group in which the two nasal shields of the head are in contact; and that in a second group, as represented by *Cantoria*, they are separated by an internasal shield. Most of these snakes are of small size, few of them exceeding a yard in length, while many are considerably smaller. Although mainly fresh-water snakes, seldom coming to shore, a few members of the group enter the sea. Many of them are furnished with prehensile tails, by means of which they attach themselves to convenient objects; and the majority feed exclusively on fish, though a few prefer crustaceans. Their young are produced alive in the water.

Coral Snake The beautiful but venomous coral snake (*Elaps corallinus*) is the best-known representative of a genus which brings us to a third and last series of the great family under consideration. All the members of this front-fanged series (*Proteroglypha*) are characterized by having the front teeth of the hinder upper jawbone or maxilla, grooved, and the posterior ones simple and solid. These snakes are all poisonous; and they are divided into two subfamilies, according to their habits and the conformation of the tail. In the first, or Elapine subfamily (*Elapinae*) the tail is cylindrical; the snakes themselves being either terrestrial or arboreal in their mode of life. These Elapine snakes are distributed in larger or smaller numbers over Asia, Africa, and America, and are especially abundant in Australia, where they form by far the greater moiety of the ophidian

fauna. All of them — doubtless on account of the immunity from attack conferred by their poisonous character — are remarkable for the beauty of their coloration.

The coral snake and its allies constitute a genus well represented in the warmer regions of America, but also occurring sparingly in South Africa. They are small, although rather long and plump serpents, with the body cylindrical, the head flattened and scarcely differentiated from the neck, and the tail short. The small eye has a circular pupil, the mouth is narrow, and the jaws admit of but slight dilatation. Superiorly, the body is clothed with equal-sized, smooth scales, arranged in fifteen rows; while inferiorly the body shields are rounded, the anal one being undivided, and the shields beneath the tail arranged in a double series. Behind the fangs, the teeth are all small. One of the handsomest members of a beautiful group

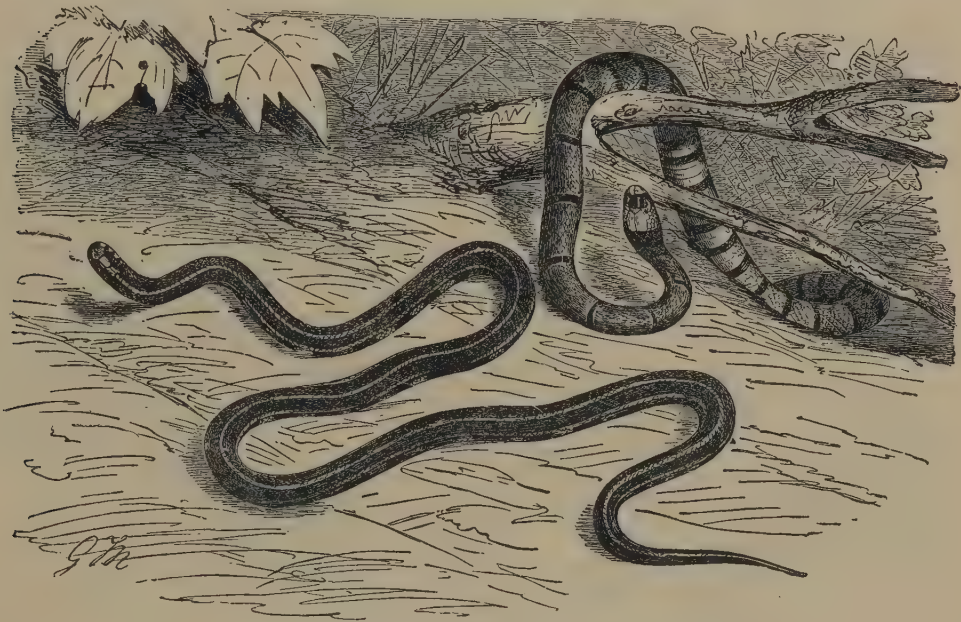


CORAL SNAKE.
(Two-thirds natural size.)

is the coral snake, which inhabits a large part of South America, and also occurs in the West Indies. Attaining a length of from two feet to two and one-fourth feet, this snake has its ground color a brilliant cinnabar red, with a special lustre on the under parts. On the body this red color is divided into sections of equal length by broad black rings, bordered by more or less distinct greenish white margins; all the red and greenish portions showing black spots on the tips of the scales. The front of the head, as far back as the hinder end of the frontal shields, is bluish black; at the back of the parietal shields there commences a greenish white cross band, running behind the eye, and occupying the whole of the lower jaw; and after this comes a black neck ring, followed by one of the red spaces of the body. As a rule, instead of being red, the tail has alternations of black and whitish rings, with

its tip whitish. The coral snake is generally met with in forests, the neighborhood of human dwellings it strictly avoids. Somewhat slow in its movements, it is unable to climb trees; and its food consists of other snakes, lizards, insects, and centipedes.

In Asia the place of the coral snake and its allies is taken by a group of nearly-allied species which may be collectively termed resplendent adders. From the last genus these are distinguished by the presence of a distinct groove along the whole of the front surface of the upper fangs, and also by the scales being arranged in thirteen rows. None of the teeth behind the fangs are solid, and the shields on the head (among which the loreal is wanting) are of large size. A further difference from the American genus is to be

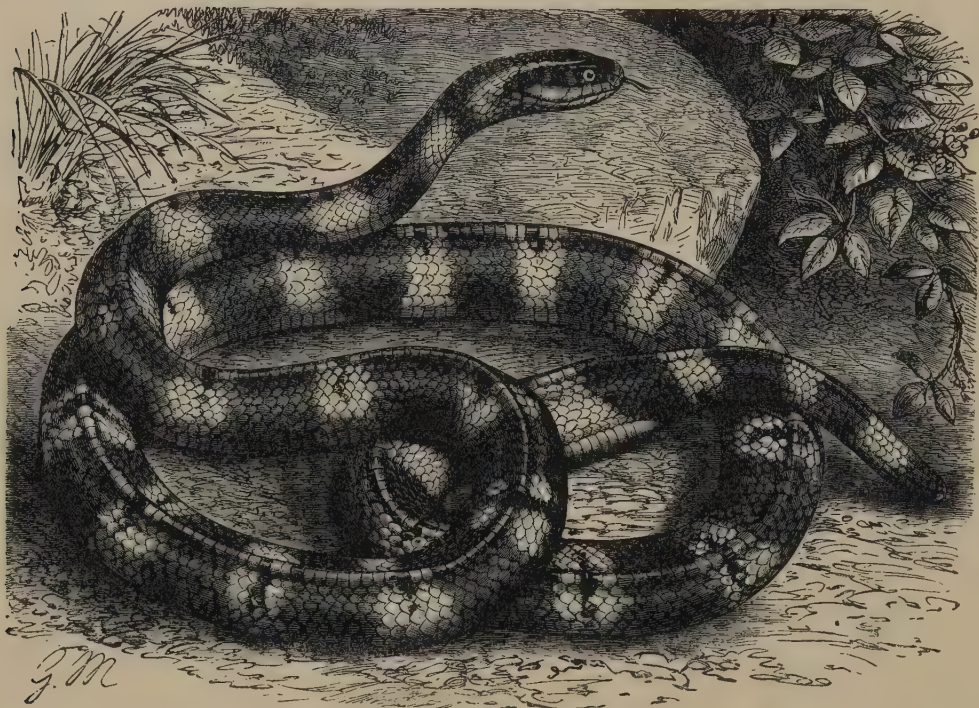


LONG-GLANDED SNAKE AND MASKED ADDER.
(One-half natural size.)

found in the presence of postfrontal bones in the skull. These adders, which are mostly less than three feet in length, are represented by seven species, spread over the Oriental region, Southern China, and Japan. The masked adder (*Callophis maclellandi*), which attains a length of twenty-six inches, and ranges from Nipal to the south of China, is generally reddish-brown above, with regular black, light-edged transverse rings placed at equal distances from one another, the under parts being yellowish with black cross bands or squarish spots. The resplendent adders resemble the coral snake in the slowness of their movements, and their inability to ascend trees, their favorite resorts being hilly districts. They closely resemble the harmless snakes of the genus *Calamaria*, upon the different species of which they chiefly feed.

Long-
Glanded
Snakes

Closely allied to the preceding are two snakes from Burma and the Malayan region which merely differ in that the poison glands, instead of being confined to the back part of the head, extend along each side of the body for about a third of its total length, gradually thickening till they end in front of the heart in club-shaped expansion. The heart being thrown further back in the body than ordinary, these snakes may be recognized externally by the thickening of that region. The figured species (*Adeniophis intestinalis*) is an extremely elongated and slender snake, inhabiting Burma and the Malayan islands, and attaining a length of two feet. It is generally brown



BANDED ADDER, OR RAJ SAMP.
(One-fourth natural size.)

above with a yellowish black-edged line running down the middle of the back, and a nearly similar one on each side of the body; the under parts being banded with yellow and black.

Craits

Although the native name crait applies properly only to a single member (*Bungarus ceruleus*) of this genus, it may be conveniently extended to include the whole of the eight species, which range from India to the south of China, five occurring in India and Ceylon. Closely connected with the resplendent snakes by the genus *Hemibungarus*, in which a solid tooth is present behind the fangs, the craits have from one to three small solid teeth behind these; and the smooth scales are arranged in thirteen or fifteen rows, with the middle row

of the back larger than the others. The head resembles that of the last genus in being imperfectly distinguished from the neck, as well as in the size and number of its shields; the small eye has a similar round pupil. The tail is of moderate length, or short, with the shields on its lower surface arranged in either a double or single series. The banded adder (*B. fasciatus*) belongs to a group in which the shields on the lower surface of the body are very large, and broader than long, those of the tail being arranged in a single series. The species is distinguished by the presence of a distinct ridge along the back, by the obtuse extremity of the tail, and by the front temporal shield of the head being scarcely longer than deep; these three features distinguish it from the blue adder or crait (*B. cæruleus*) and the nearly-allied Ceylon crait (*B. ceylonicus*). The banded adder, or raj samp (king snake), ranges from Bengal to Java, and commonly measures about four feet in length, although it grows to six feet. In color it is bright yellow, with black rings equal to or exceeding in length the light interspaces; on the head a black band commences between the eyes and widens toward the nape of the neck; the tip of the muzzle being brown. The crait is of a dark, almost steel-blue black, or chocolate-brown, color, with narrow white crossbars, streaks or rings of white; the under surface being of a dark livid hue, or whitish or yellowish. It inhabits the whole of India, but is not so large as the raj samp, which is probably as poisonous, though it does not come much into contact with human beings, and is, therefore, a less terrible destroyer of life. The crait frequently insinuates itself into houses, where it conceals itself in bathrooms, verandas, cupboards, or between the bars of shutters; and an instance is on record where one was discovered coiled up beneath the pillow of a palki in which a lady had made a night's journey. Next to the cobra, the crait is credited with killing more human beings in India than any other snake.

Cobras

The name "cobra de capello" or hooded snake was applied by the Portuguese in Ceylon to the common Indian representative of a genus of deadly serpents distinguished from the craits by their power of inflating the neck, and likewise by the scales in the middle of the back not being larger than the rest. By Europeans these snakes are now generally known by the name of cobras. Agreeing with the craits in having the fangs furnished with a complete groove on the front surface, and likewise by the presence of from one to three solid teeth behind them, the cobras have the head distinct from the neck, and covered with large shields, among which the loreal is wanting; the eye being rather small, with a round pupil. The body is cylindrical, with the smooth scales disposed in fifteen or more oblique rows; the tail is of moderate length, with its inferior shields in either a single or a double series. The dilatation of the neck, which always takes place when they are excited and about to strike, at once serves to distinguish the cobras from all other snakes. Cobras are confined to Africa and Southern Asia, and are represented by six or seven species, two of which are found in India, and a third in Java and Borneo, the others being African. Of the Indian forms, by far the most abundant is the common or true cobra (*Naia tripudians*), which is known to the natives of India as the kala nag or kala samp (black snake). Distinguished by having no large shields on the head behind the parietals, and by the whole of the shields on the under surface of the tail being arranged in a double series, this

snake is a very variable species as regards coloration, some examples having a dark spectacle-like mark on the back of the hood, while others have only a single eye-like spot, and others, again, have no mark at all in this region. In regard to coloration, Mr. Boulenger remarks that the hue of the upper parts may be grayish brown or black, with or without a spectacle—or loop-shaped black light-edged marking on the neck—or with light spots or cross bands on the body; while beneath



YOUNG GIANT COBRA OR HAMADRYAD.
(One-seventh natural size.)

it varies from whitish, through brownish, to blackish, sometimes with black cross-bars on the fore part of the body. Occasionally attaining a length of a few inches over six feet, while an instance is on record where a specimen measured upward of seven feet three inches, this cobra is distributed over the whole of India and Ceylon, ranging westward through Afghanistan to the Caspian, and to the east to the Malayan region, and the south of China. The other Indian species or giant

cobra (*N. bungarus*) is a larger snake, distinguished by the presence of a pair of large shields on the head behind the parietals, while the shields beneath the tail usually form only a single series. When adult, its color is yellowish or brown, with more or less distinctly-marked dark cross bands; but young specimens are usually black, with yellow rings on the body and bars on the head, and in some instances there are light spots on the upper surface, and the inferior shields are whitish with black margins. In size, the giant cobra is known to measure as much as thirteen feet, and probably grows larger. Fiercer than the common species, this cobra is fortunately far less abundant; its range extending from India through Burma and Siam to the Malayan region and the Philippines. Another species is the asp or Egyptian cobra (*N. haie*) which is widely spread over Africa, and presents great variations in color. Somewhat exceeding in size the true cobra, the asp is distinguished by the sixth upper labial shield of the head much exceeding the others in length, and uniting with the temporal, so as to form a large plate, which anteriorly comes in contact with the postocular shield. In most Egyptian examples the color of the upper parts is uniformly straw yellow, while the under parts are light yellow; but there may be dark cross bands on the under surface of the region of the neck, which sometimes unite into a patch. The straw color may, however, shade into blackish brown and occasionally the hues may be brighter.

Habits

Our account of the habits of these snakes will be mainly confined to the common Indian species, and since these have been specially studied by Sir J. Fayrer we shall paraphrase or quote from his writings. Although frequently seen in motion during the day, cobras are most active during the night; and they feed chiefly on small mammals, birds' eggs, frogs, fish, and even insects. The giant cobra subsists, however, almost entirely on other snakes; and the other species will occasionally rob hens' nests, swallowing the eggs whole. In captivity, cobras will live weeks and even months without tasting food of any kind or touching water. Although essentially terrestrial, they will readily enter water, in which they swim well; while they occasionally climb trees in search of food, and are often found, more especially during the rainy season, in old buildings and walls, or in wood stacks and heaps of rubbish. It is when collected in such situations that they are most commonly trodden upon by the natives — and more frequently at night than at other times — with the well-known fatal results. These snakes lay from eighteen to twenty-five oval eggs about the size of those of a pigeon. Ascending to a height of some eight thousand feet in the Himalayas, the common cobra "is equally dreaded and fatal wherever met with; fortunately it is not naturally aggressive, unless provoked, at which times its aspect is most alarming. Raising the anterior third or more of its body, and expanding its hood, with a loud hissing, it draws back its head prepared to strike, and, when it does so, darts its head forward, and either scratches, or seizes and imbeds its fangs in the object of attack. If the grasp be complete and the fangs imbedded in the flesh, dangerous and often fatal effects result; but if the fangs only inflict a scratch, or if the snake be weak or exhausted, the same great danger is not incurred. If the poison enter a large vein and be quickly carried into the circulation, death is very rapid; men having been known to perish from cobra bite within half an hour. The largest and strongest

as well as the smallest and weakest creatures succumb; but, fortunately, all who are bitten do not die. In the first place, some human beings, as well as lower animals, have greater tolerance than others of this or of other poisons — a result, doubtless, of idiosyncrasy or varying degrees of nervous energy which enables one to resist that to which another would yield; or a wound may have been inflicted and yet but



SHORT DEATH ADDER AND SPINE-TAILED DEATH ADDER.
(One-fourth natural size.)

little of the poison inoculated; or, in the third place, the snake may be weak or sickly, or it may have been exhausted by recent biting, and thus have become temporarily deprived of the power of inflicting a deadly wound. But when a cobra in the full possession of its powers bites, and injects the poison into man or beast, it is almost surely fatal, and all the remedies vaunted as infallible antidotes are futile."

Death Adders Among the deadliest of Australian snakes is the purplish death adder (*Pseudechis porphyriaca*), alone representing a genus characterized by the great elongation and slenderness of the cylindrical body, the sharply-pointed tail, the small head, imperfectly differentiated from the neck and clothed with large shields, the smooth scales, arranged in from seventeen to twenty-three rows, the divided anal shield, and the arrangement of the shields on the under surface of the tail at first in a single, and posteriorly in a double series. Behind the fangs are one or two solid teeth in the upper jaw; the pupil of the eye is round, and the neck cannot be dilated. This snake, which grows to a length of about seven feet, is very variable in coloration. Generally, however, the color of the back varies from a shining purplish black to dark olive brown, the under parts being red, and the sides carmine; but the latter colors not occupying the centres of the scales, which are black, as are the hinder borders of the shields of the under surface. Generally known to the settlers by the name of the black snake, this reptile is dreaded alike by natives and Europeans, although, fortunately, it nearly always endeavors to escape when discovered. The short death adder (*Hoplicephalus curtus*), represented in the upper figure of the illustration on p. 2588, is selected as a well-known example of a second Australian genus, which includes a large number of species. Closely resembling the harmless snakes in general appearance, these death adders are distinguished from the other members of this group by the presence in the upper jaw of a row of small, curved, solid teeth behind the fangs. The head is unsymmetrically four sided, flattened, and rounded at the muzzle, the body massive, and the tail either moderate or short. The smooth and equal-sized scales are arranged in from fifteen to twenty-one rows, those on the middle of the back not being larger than the rest, and there is but a single row of shields on the under surface of the tail. All these species are peculiar in the group for producing living young. The figured species, which varies from three to four feet in length, has a short tail and nineteen rows of scales. Although very variable as regards coloration, the head is generally uniform black, the body olive color, with broad brown or black cross bands, the hinder part of the body and the upper surface of the tail uniformly blackish, and the whole of the under parts light yellow. Some specimens have, however, no dark bands on the back. The spine-tailed death adder (*Acanthopis antarcticus*), depicted in the lower figure of the illustration, represents a genus easily recognized by the horny appendage with which the tail terminates; the middle row of scales in the fore part of the body being more or less distinctly keeled. In addition to Australia and New Guinea, this snake also inhabits the Eastern Moluccas, as well as Ceram and Amboyna. It feeds chiefly upon frogs and young birds and is regarded by Europeans as most deadly, although the natives believe that no one ever dies from a death adder's bite.

Sea Snakes The sea snakes are now considered to represent merely a subfamily (*Hydrophiinæ*) of the front-fanged Colubrines. From the preceding subfamily they are distinguished, not only by their marine habits, but likewise by their strongly-compressed and oar-shaped tails, in the skeleton of which both the superior and inferior spines of the vertebræ are very strongly developed. With the exception of the broad-tailed sea snakes, which form a kind of transition between

the present and preceding subfamilies, these snakes never leave the water; and the inferior surface of the body and tail is either covered with scales similar to those on the upper parts, or, if shields are present, they are of small size. All are very poisonous, and produce living young. Their headquarters are the coasts of the Indian Ocean and the tropical districts of the Western Pacific, their range extending from the Persian Gulf to New Guinea and Northern Australia. The parti-colored sea snake has, however, a more extensive distribution, ranging from the western coast of Africa to the western shores of tropical America, and extending as far north as Japan and Manchuria, and as far south as New Zealand. All of them have



BANDED SEA SNAKE.
(One-third natural size.)

relatively-small heads, jaws, and fangs; and while in some cases the body is short and thick, in others it is very thick only in the region of the tail, and elsewhere disproportionately elongated and attenuated. Always varied, the coloration is often brilliant and beautiful; and the oar-like form of the tail and hinder part of the body is obviously an adaptation to an aquatic life. Living in the sea, or in tidal waters, their movements in the clear blue water are agile and elegant; but when thrown ashore, as frequently happens, the majority are helpless. Their food consists of fish and such other creatures as they can capture in the sea. In parts of the Bay of Bengal, sea snakes are sometimes seen congregating in large shoals. The group is divided into nine genera, no less than six of which are represented in Indian waters.

**Broad-Tailed
Sea Snakes** The broad-tailed sea snakes, of which there are three species, constituting the genus *Platurus*, in general appearance closely resemble some of the craits, especially as regards the shape of the skull and the scaling of the head and body, but are distinguished by the compression and depth of the tail. In the upper jaw, which is very short, there is in the maxilla of each side a pair of large grooved fangs, followed by a single very small solid tooth. The arrangement of the shields of the head is normal, each nostril being pierced in a laterally-placed nasal; the scales on the body are smooth and overlapping, and the inferior surface is covered with large shields. Of the three species, the banded sea snake (*P. laticaudatus*) is distinguished by the absence of a keel on the lower



BLACK-BANDED SEA SNAKE.
(Two-thirds natural size.)

surface of the hinder part of the body, and also of an unpaired shield on the muzzle; the scales being arranged in nineteen rows. In color it is olive above and yellowish beneath, with black rings fully equal in width to the light interspaces. Attaining a length of a little over a yard, this species ranges from the Bay of Bengal and the China Sea to Polynesia. An allied but larger species (*P. colubrinus*), with the same distribution, is distinguished by the presence of an unpaired shield on the head, and the arrangement of the scales in from twenty-one to twenty-five rows; while the third species (*P. schistorhynchus*) from the China Sea and Western Pacific differs in having a keel along the hinder half of the lower surface of the body. That the broad-tailed sea snakes are the direct descendants of terrestrial forms allied to the craits, is proved by their retention of large inferior

shields, and by their habits. Not only are these snakes frequently found at some distance from water, but in Sumatra a specimen was captured nearly a day's march inland.

In common with all the other members of the subfamily, the **Parti-Colored Sea Snake** colored sea snake (*Hydrus platyurus*) has the nostrils placed on the upper surface of the muzzle; and the under surface of the body and tail in this species are scaled like the rest, although in some of the genera traces of enlarged shields still persist. In the skull, the maxilla is considerably longer than the tranverse bone, and carries a pair of short fangs, followed, after an interval, by seven or eight solid teeth; the muzzle is elongated; the head shields are large, the nasals being in contact with one another; and the scales on the relatively-short body hexagonal in form and with their edges in apposition. This snake attains a length of a yard; and in color is either yellowish with symmetrical black transverse bands or spots, or uniformly black above and yellow, with or without black spots below; the yellow tail being ornamented with either black spots or bars. It is the sole representative of its genus, and has a wider distribution than any other member of the group, ranging over the whole of the Indian Ocean and the tropical and subtropical portions of the Pacific. The typical sea snakes, forming the large genus *Hydrophis*, differ in having from seven to eighteen solid teeth in the maxilla, by the longer body, on the anterior part of which the scales are imbricating, and by the presence of more or less distinct small shields on the lower surface.

The black-banded sea snake (*Distira cyanocincta*) may be taken as an example of another large genus differing from the preceding in that the fangs are followed in the maxilla by from four to ten solid teeth with their front surface grooved. In these snakes the body is more or less elongated, and generally has the scales on its front portion slightly overlapping, while the under surface carries small shields. The figured species, which grows to a length of six feet, is of a greenish olive above, with black transverse bars or rings, which are sometimes connected by a longitudinal stripe on the under surface. This snake ranges from the Persian Gulf to the Malay Archipelago and Japan, and is one of the most abundant in the Indian seas.

There are several points in which the sea snakes differ from their land cousins as regards habits, in addition to those already noticed. In the first place, the skin is changed piecemeal, instead of entire; the casting taking place at very frequent intervals. Moreover, the tongue is very short, and only the extreme tips of its two extremities are exerted through small notches on either side of the rostral shield of the head, which is prolonged downward so as to close the mouth. When, however, these snakes are cast ashore and almost blinded by the unaccustomed light, the tongue is used in the ordinary manner as a feeler.

THE VIPERS

Family *VIPERIDÆ*

Omitting mention of the small and unimportant family of harmless snakes known as blunt heads (*Amblycephalidæ*), represented by two Oriental and two tropical American genera, we pass to the viper family, which includes the whole of the remaining members of the suborder. The distinction between a colubrine and viperine snake is that in the latter the maxillæ or hinder upper jawbones are capable of being erected in a vertical plane at right angles to the transverse bones, while in form they are short and thick, and they always carry a single pair of large tubular fangs. All vipers are poisonous, and, so far as known, produce living young; while they are more or less nocturnal and terrestrial in their habits, although a few ascend trees. The thick body, the flat and often triangular head, the short and stumpy tail, the reduction of the maxillary teeth to a single pair of fangs, and the vertical pupil of the eye, are all features distinguishing vipers as a whole from the poisonous colubrines; but, as already mentioned, it is frequently necessary to examine the structure of the skull itself before any particular snake can be assigned to its proper serial position. That the vipers form a highly specialized group is self-evident; and Mr. Boulenger believes them to be descended from the hind-fanged colubrines. The family is divided into two groups, namely, the typical vipers of the Old World, which attain their maximum development in Africa, and the American and Asiatic pit vipers.

True Vipers Our first representatives of the Old-World vipers (*Viperinæ*) are the true vipers, which form a genus with some twenty species, ranging over Africa (exclusive of Madagascar), Europe, and a large portion of Asia, one of them reaching India. In common with the other members of the subfamily, they have no pit in the loreal shield of the head; while they are specially distinguished by the upper surface of the head being covered either with scales or small shields, and by the keeled scales of the body running in straight longitudinal rows, which vary in number from twenty-one to thirty-eight; and likewise by the double row of shields beneath the tail.

Common Viper The common viper (*Vipera verus*), which is happily the only British poisonous snake, is one of the smallest representatives of the genus, and is distinguished by the mixture of scales and shields on the head (three of the latter being larger than the rest), and the general presence of only a single row of scales between the eye and the upper labial shields beneath. In color and markings the common viper is extremely variable; but as a rule a dark zigzag stripe runs down the whole length of the middle of the back. With regard to coloration, in some specimens the ground color is nearly olive, in others a deep rich brown, and in others, a dirty brownish yellow; while a mark between the eyes, a spot on each side of the hinder part of the head, the above-mentioned zigzag line formed of confluent quadrangular spots on the back, and a row of small irregular triangular spots on each side of the body, are of a darker hue than the ground color, and are fre-



(2594)

A FAMILY OF VIPERS.

quently nearly black. In some examples the under parts are lead color, with lighter or darker spots, while in others they are almost wholly black. Bell records a specimen in which the ground color was nearly white and the markings black; and in one variety the ground color is brick red, with ferruginous markings; while in a second the under parts acquire a more or less marked blue tinge; and in a third the whole skin, with the exception of that beneath the jaw and throat is black, the usual markings being visible in certain lights. The average length of the common viper is about ten inches. Its geographical distribution is greater than that of any other European snake, extending from Portugal eastward to the island of Saghalien, while northward it reaches to the Arctic Circle, and southward to Central Spain.



LONG-NOSED OR SAND VIPER.
(One-half natural size.)

Southern Viper In Southwestern Europe the common viper is replaced or accompanied by a closely-allied form which may be called the southern viper (*V. aspis*), regarded by some writers as a distinct species, and by others as a mere variety. As it was doubtless to this snake that the Latin term *Vivipara* was applied, German writers restrict the name viper to the southern form, and use the term *Kreuzotter* for the common viper. In the latter the front of the upper surface of the head is covered with three distinct small shields, but in the southern form it

is clothed only with smooth or slightly-ridged scales, among which seldom more than a single polygonal roundish one can be regarded as representing a frontal shield; moreover, instead of the single row of small scales generally separating the eye of the common viper from the upper labial shields, the southern form always has two such rows. There is likewise a difference in the shape of the muzzle in the two forms. The southern viper may be considered characteristic of the Mediterranean countries, occurring in North Africa as well as in Europe. It is noteworthy that in the borderland of the distributional areas of the two forms, such as Northern Spain and Italy, it is difficult to say to which of the two any specimen may belong.

More numerous in Scotland than the ringed snake, but, like it, unknown in Ireland, the common viper generally frequents heaths, dry woods, and sandy banks. Although its bite produces severe effects, it is seldom, unless the sufferer be very young or in ill health, that death ensues. During the winter months, vipers generally hibernate in small parties for the sake of mutual warmth, several being often found twined together in a torpid condition.

**Long-Nosed
Viper**

Another well-known poisonous European snake is the long-nosed or sand viper (*V. ammodytes*) easily recognized by the presence of a soft horny appendage at the end of the nose, covered with scales, and not unlike a conical wart in appearance. It is also distinguished from the common viper by the absence of any large shield, except the supraoculars, on the top of the head; although in coloration the two species are very similar. In size it is the largest European representative of the group, attaining a length in some rare instances of just over a yard. The sand viper ranges from Italy to Armenia. In Carinthia it is the commonest of snakes, while in the Tyrol it is local, but abundant in the south of Hungary and Dalmatia. Mainly nocturnal it is much more commonly found in hilly than in level districts, ascending in the mountains to a height of between three thousand and four thousand feet. Except during the pairing season, when it is found in couples, it is a solitary creature, subsisting on other snakes, mice, voles, birds, and lizards.

**Russell's
Viper**

As being one of the deadliest of Indian snakes, we may take as our next example of the genus the beautiful Russell's viper (*V. russelli*) of India, Ceylon, Burma, and Siam. From the other viper inhabiting Kashmir, this species may be distinguished by having the rostral shield of the head as long as broad, and the scales on the body arranged in from twenty-seven to thirty-one rows. Sometimes known as the chain viper, this snake attains a length of four feet. Its ground color is pale brown, with three longitudinal series of black light-edged rings, sometimes replaced by faint dark spots, the lower parts being yellowish white, either with or without small crescentic black spots. In young specimens, as shown in our illustration, the black rings on the upper parts surround dark reddish-brown spots, which in the middle series are in contact with one another. Sir J. Fayrer regards this snake as being, next to the cobra, the most dangerous in India, stating that fowls bitten by it sometimes expire in less than a minute. "It is nocturnal in its habits, is sluggish, and does not readily strike unless irritated, when it bites with great fury; it hisses fiercely and strikes with vigor. Its long movable fangs are very prominent objects, and with them it is capable of inflicting

deep as well as poisoned wounds. When disturbed, its loud hissing is calculated to warn those who approach it, and it does not appear to cause many human deaths, although it may be that its misdeeds are sometimes ascribed to the cobra. This viper is said to frequently kill cattle while grazing, by biting them about the nose or mouth. In proof of its sluggish nature, there is a well-authenticated tale of a young person having picked one up, and, mistaking it for an innocent snake, carried it home, its true character being only discovered when it bit a dog."



RUSSELL'S VIPER.
(One-half natural size.)

Puff Adder In Africa the place of Russell's viper is taken by the dreaded puff adder (*V. arietans*), which occasionally attains a length of six feet. It is the only member of the genus in which the unusually small nostrils open upward near the extremity of the muzzle; and it is further distinguished by having a supranasal shield, covered, like the region of the brow, with upright horny scales or spines. In appearance most hideous and repulsive, this snake has the large and flattened head triangular in shape, very broad and blunt at the muzzle, and sharply defined from the body, the latter being thick and almost triangular in section. Both head and body are covered with keeled overlapping scales, differing from one another only in size, and arranged on the body in from thirty-one to thirty-three

longitudinal rows and forming three or four series between the eyes and the upper labials. The coloration and marking vary to a certain extent individually; but there is a great change in the brightness of the tints immediately after the changing of the skin. The puff adder is spread over nearly the whole of Africa, and is everywhere dreaded from its deadly nature. Inhabiting dry and sandy places, it derives its name from its habit, when angry or alarmed, of drawing in a full breath and causing the body to swell visibly. Then the air is allowed to escape gradually, producing as it does so a prolonged sighing or blowing sound which continues till the lungs are emptied, this process being repeated so long as the provocation lasts.

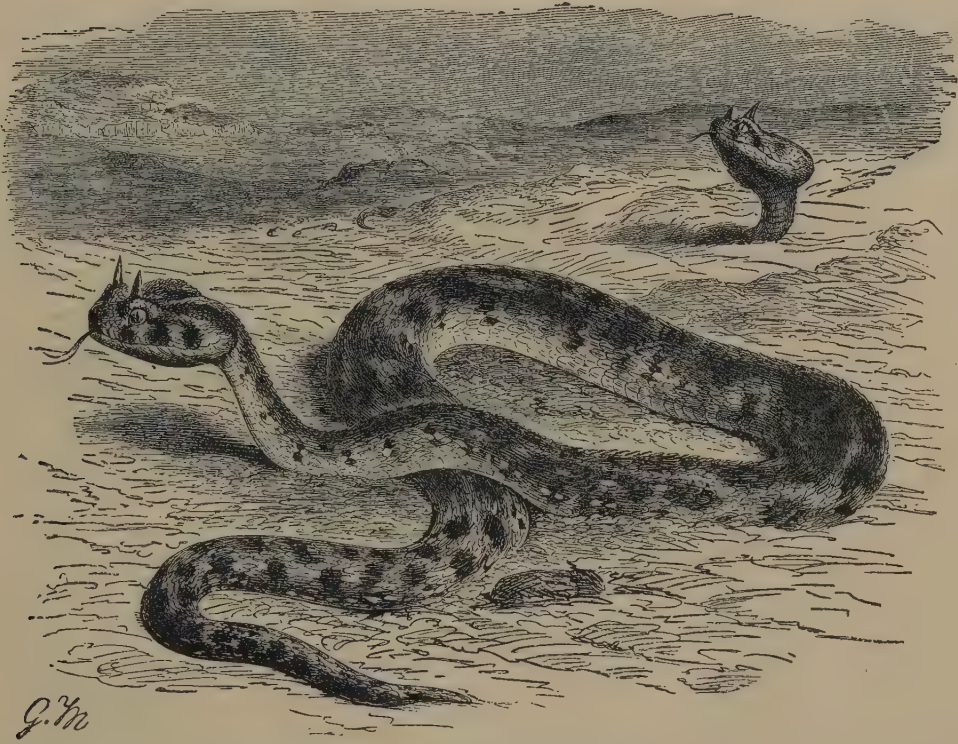


THE PUFF ADDER.
(One-fifth natural size.)

Usually this reptile lies half hidden in the sand, with its head fully exposed, and when approached merely rises without attempting to escape, and so virulent is its bite that even horses have been known to die within a few hours after being bitten. The poison is used by the bushmen for their arrows, to the tips of which it is made to adhere by being mingled with the viscid juice of the amaryllis.

Next to the southern viper, or asp, no serpent was more feared by the ancients than the Egyptian cerastes or horned viper (*Cerastes cornutus*). As a genus, the two species are characterized by the small crescentic nostrils situated on the sides of the muzzle, the presence in the male and sometimes

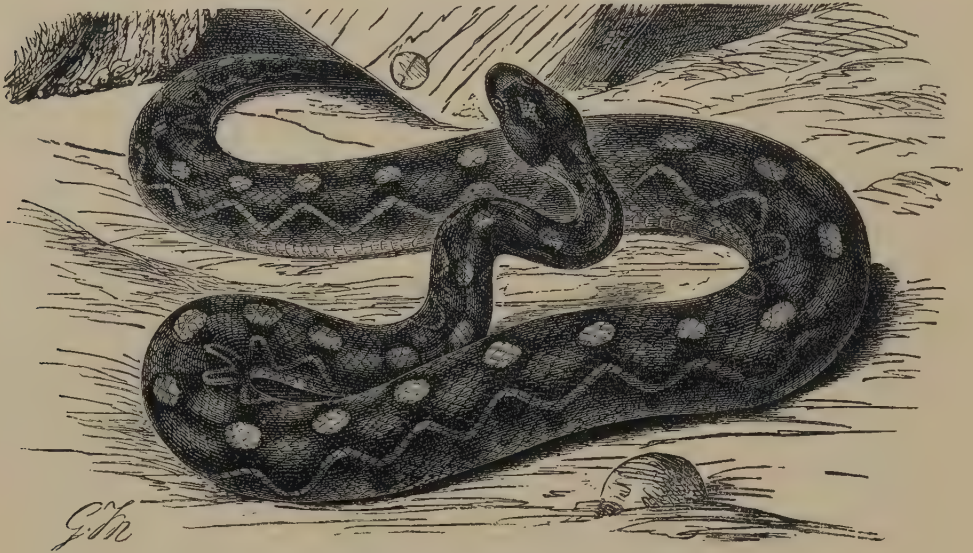
in the female, of a pair of scale-covered, horn-like processes above the eyes, the arrangement of the scales of the body in oblique rows, and the short keels on the scales, which stop short of their tips. The common horned viper may be immediately recognized as an inhabitant of desert places from the general sombre and mottled tone of its coloration, which is so admirably adapted to such surroundings. Usually attaining a length of about two feet, it is of a light brownish ground color, more or less tinged with yellow, upon which are six longitudinal rows of circular or quadrangular dark markings, increasing in size from the middle of the back toward the sides. Beneath the eyes run a dark brown band, while the middle of the head is marked by a light brownish yellow streak, dividing posteriorly, and uniting on



HORNED VIPERS IN THE SAND.
(One-half natural size.)

the sides of the neck with another stripe coming from the chin. The scales surrounding the mouth are a bright sandy yellow, the shields on the under surface being also either bright yellow or whitish. The scales of the body are arranged in from twenty-nine to thirty-three rows; the anal shield is single, while the shields beneath the tail form a double series. The range of this snake includes Northern Africa, east of Morocco, as well as Kordofan and Arabia, the second species being likewise North African. Canon Tristram writes that the usual habit of the horned viper is "to coil itself on the sand, where it basks in the impress of a camel's foot-

mark, and thence suddenly to dart out on any passing animal. So great is the terror which its sight inspires in horses, that I have known mine, when I was riding in the Sahara, suddenly start and rear, trembling and perspiring in every limb, and no persuasion would induce him to proceed. I was quite unable to account for his terror, until I noticed a cerastes coiled up in a depression two or three paces in front, with its basilisk eyes steadily fixed on us, and no doubt preparing for a spring as the horse passed," According to Bruce, this snake, when about to attack, moves rapidly forward with a sideways motion, unlike that of any other serpent. Attacking when quite unprovoked, the horned viper is more dreaded than any other North-African snake, men frequently dying from its bite within half an hour. Its food consists of desert-haunting rodents, together with lizards, and perhaps birds.



THE EJA OR DESERT SAW VIPER
(Three-fifths natural size.)

**Desert Saw
Vipers**

While agreeing with the horned vipers in having the lateral body scales arranged in oblique rows, the present genus may be distinguished by its two species having but a single series of shields beneath the tail, as well as by the absence of horns. The upper surface of the head is covered with scales, and the keeled scales of the body form from twenty-five to thirty-five rows. The common desert saw viper, or as it is called in Egypt, eja (*Echis carinata*) attains a length of about two feet; and has the keels on the lateral scales of the body strongly serrated. In color it varies from pale buff to grayish, reddish, or pale brown on the upper parts, with three series of whitish spots edged with dark brown, in addition to which there may be a dark brown zigzag band along each side, while the head is ornamented with a cross or arrowhead mark; and the under parts are whitish, either with or without brown dots. This species

inhabits the desert regions of Northern Africa, Southwestern Asia, and India, being replaced in Arabia and Palestine by *E. colorata*.

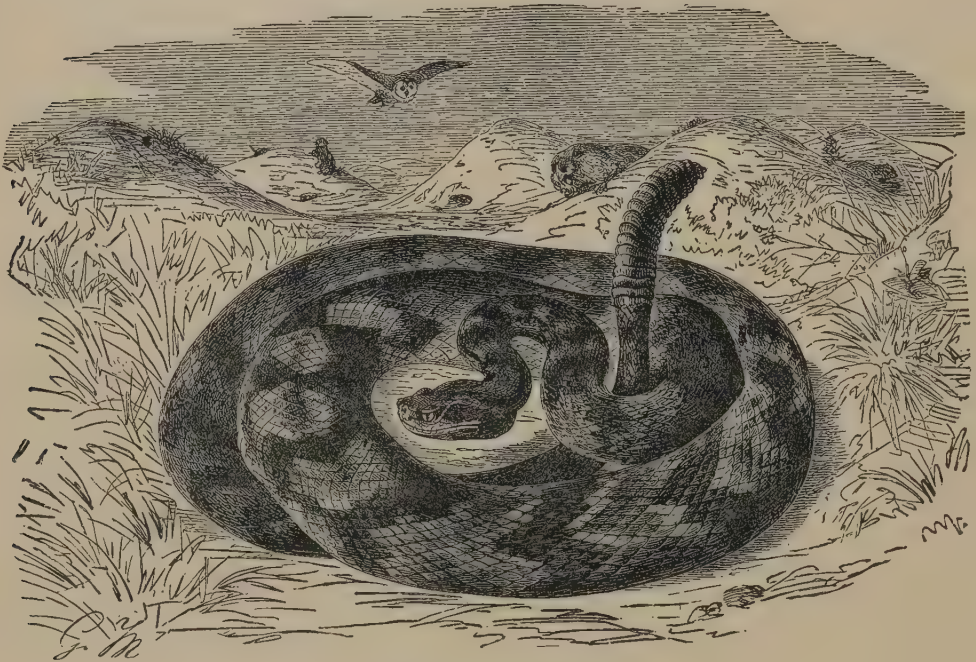
The most remarkable peculiarity of this viper (which, however, it may possess in common with the horned vipers, since the scales of the latter have a similar structure) is its power of making a curious, prolonged, almost hissing sound, produced by rubbing the folds of the sides of the body one against another, when the serrated lateral scales grate together. That this is the true cause of the sound may be proved by twisting the body of a dead specimen, and thus causing friction between the scales. Sir J. Fayrer writes that this species is a very fierce and vicious viper; it throws itself into an attitude of defense and offense, coiled up like a spring, rustling its carinated scales as it moves one fold of the body against another. It is aggressive, and does not wait to be attacked before darting its head and body at its enemy, the mouth wide open, and the long fangs vibrating, thus presenting a most menacing appearance. It is very poisonous, and there can be little doubt that it destroys many human lives, as men are much more exposed to contact with this species than with Russell's viper.

Rattlesnakes The dreaded rattlesnakes of the New World are our first representatives of the subfamily of pit vipers (*Crotalinae*), which are common to Asia and America, and are characterized by the presence between the nostril and the eye of a deep pit in each loreal shield, the physiological significance of which is still unknown. All have triangular broad heads and short thick bodies. The Asiatic representatives of the group are less deadly serpents than their American relatives; while the only vestige of the rattle of the latter to be found in the former is a small horny spine at the end of the tail of one species. Many of the Indian species are arboreal in their habits; their coloration assimilating to that of the foliage and boughs among which they dwell. As regards their geographical distribution, pit vipers present a curious similarity to bears and deer; and since they are most abundant in the Oriental region, and also more numerous in North than in South America, Mr. Wallace is of opinion that the group originated in the Indo-Chinese countries, and thence spread northeastward to North America, and so onward to the southern half of the New World, which area, having been the last to receive the group, has not had time, in spite of its extreme fitness for reptilian life, to allow it to attain its full development.

The rattlesnakes are sufficiently distinguished from their allies by the jointed, horny appendage at the end of the tail from which they derive their name. In the young rattlesnake the tail terminates in a somewhat nail-like "button," which in a perfect rattle remains at the tip, the various rings, which may reach to twenty or more in number, being gradually interpolated between this and the scaly portion of the tail. More or less symmetrical in form, the rattle is composed of hollow, horny rings, somewhat like quill in substance, which are interlocked with one another, and are yet so elastic as to allow a considerable amount of motion between them. The various rings do not appear to be formed with any regularity, sometimes several being added in a single year, while at other seasons but one is developed; neither does there seem to be any relation between the growth of the rattle and the changing of the skin. That very large rattles must, however, belong to old snakes

is obvious; and that this is really the case is shown by the circumstance that at the present day rattles with twenty rings are very seldom met with, since with the advance of cultivation it is only rarely that these noxious reptiles are suffered to attain their full age. The body is thick, and, for poisonous snakes, somewhat long; and the poison glands attain very large dimensions.

Common Rattle-snake Since the rattlesnakes are extremely variable in coloration, reliance has to a great extent to be placed on the arrangement of the shields covering the fore part of the head in the discrimination of the species. In the common rattlesnake (*Crotalus durissus*) of North America, the distinctive characteristic is the presence of only two pairs of large shields between



COMMON RATTLESNAKE.
(One-fourth natural size.)

the large supraocular and rostral shields; these paired shields being separated by a series of small ones in the middle line. Of these shields, behind the large triangular rostral comes the four-sided anterior pair, representing the anterior frontals, while to each of the latter further back joins a larger oval shield which must be regarded as a lateral remnant of the hinder frontal. The space between the two last-named shields is occupied by a series of small shields, of which the front ones are the largest; and between the supraocular shields commence the long keeled scales covering the body, where they are arranged in from twenty-five to twenty-seven longitudinal rows. The ground color of the upper surface is a dull grayish brown, upon which are two rows of large, irregular spots, which may unite into

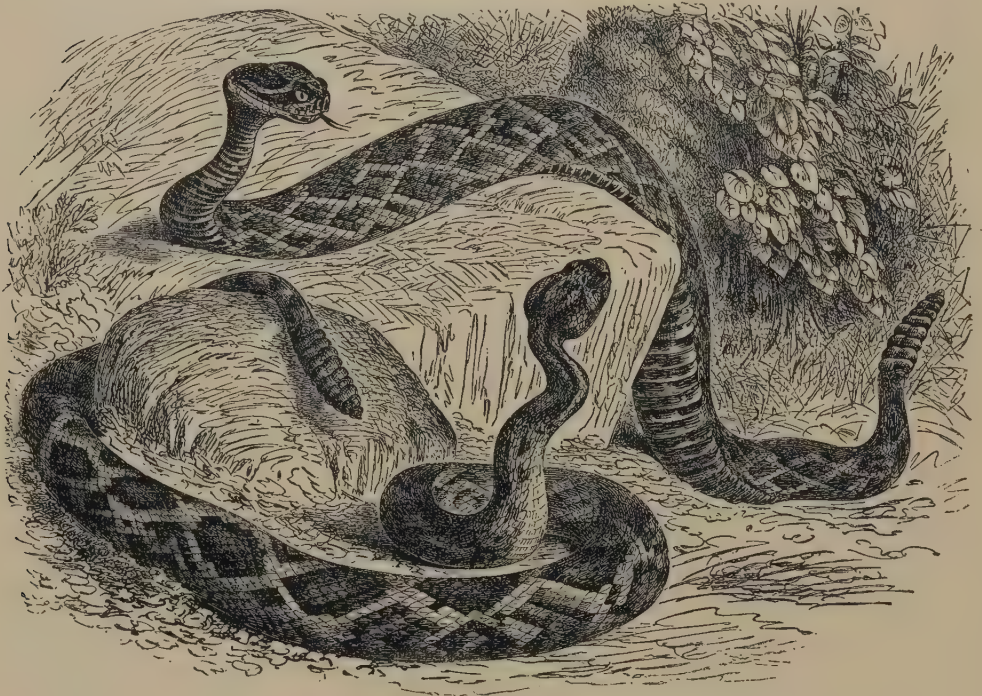
zigzag cross bands, and are gradually lost on the dark tail, the under parts being yellowish white, marked with small black dots. Generally about four and one-half feet in length, this species may grow to six feet.

Diamond Rattle-snake In the Southern United States the commonest member of the genus is the diamond rattlesnake (*C. adamanteus*), represented in the upper figure of the following illustration, which is not only the most beautiful, but likewise the largest species, adult females (which in this group are always larger than the males) not unfrequently measuring six feet in length. From the common rattlesnake it may be distinguished by the large and narrow head, on which the shields are but slightly developed, the presence of three pairs of shields between the rostral and supraocular on the top of the muzzle, by the scales of the body being always arranged in twenty-seven rows, and also by the coloration. The small rostral shield is markedly triangular, the slightly developed frontal has a roundish pentagonal form, and the great supraocular shield a distinctly overhanging edge. After shedding, the new skin is of a beautiful greenish, or occasionally golden-brown ground color; upon this is a triple of lozenge-shaped chain pattern on each side of the back, the golden yellow lines of which stand out in marked contrast to the dark diamonds of the ground color. A blackish-brown band runs from the muzzle through each eye to the corner of the mouth; and the top of the head is either uniformly colored, or ornamented with irregular markings.

South American Rattle-snakes Of the six species of the genus, four are confined to North America, and only one is found to the southward of the Isthmus of Panama. The latter species (*C. horridus*), which is represented in the lower figure of our illustration, approaches the common species as regards the arrangement of the shields on the head, while in coloration it is like the diamond rattlesnake. From the former it may be distinguished by the circumstance that the two pairs of shields between the rostral and the supraocular have no small shields between them, so that they come in contact with one another in the middle line; while from the latter the larger size of the lozenges on the body, and the presence in each of a light colored centre will serve as a sufficient distinction, in addition to the different arrangement of the head shields.

Habits In noticing the habits of these snakes our remarks will chiefly relate to the North-American species. As we have already said, rattlesnakes chiefly frequent dry and sandy localities, more especially when they are covered with bushes; but we have to add that in North America they frequently take up their abode in the burrows of the prairie marmot. Formerly it was thought that the snakes and marmots lived together in harmony, but it is now ascertained that the former prey on the young of the latter. The general food of rattlesnakes consists of small mammals, birds, lizards, and frogs, the latter being especial favorites; but mammals as large as a mink have occasionally been taken from them. The most extraordinary peculiarity connected with the common species is its habit in the colder regions of North America of collecting in enormous numbers for the winter sleep. In some districts the snakes used to assemble in hundreds, or even thousands, from all sides to sleep in the ancestral den, some of them, it is said, traveling distances of twenty or even thirty miles. Huddled together in masses for

the sake of warmth, the serpents passed the winter in a state of more or less complete torpor, until the returning warmth of spring once more started them to spread over the country. When rattle snakes were abundant, annual or biennial hunts used to take place at these dens; the fat of the slaughtered reptiles being used as a valuable supply of oil. Catlin tells us how, when a boy, he once assisted at one of these hunts at a place known as Rattlesnake Den, whence the snakes used to come forth on to a certain ledge of rock in swarms. At one time, he says, there was a knot of them "like a huge mat wound and twisted and interlocked together, with all their heads like scores of hydras standing up from the mass," into which he fired with a shotgun. Between five hundred and six hundred were killed with



DIAMOND AND SOUTH AMERICAN RATTLESNAKES.
(One-tenth natural size.)

clubs and other weapons, but hundreds more escaped to the den. Fortunately one large one was taken alive, and was made the means of destroying the rest, a powder horn with a slow fuse being applied to its tail, and the reptile allowed to crawl back to the cave, where a loud explosion soon told the tale of the destruction that had taken place.

The most interesting point in connection with rattlesnakes is the use to which the appendage from which they derive their name is put,—for use it must surely have. The old view was that it was intended to warn creatures preyed on by these reptiles of the approach of their enemy; but, in regard to this supposition, Darwin well observes that "I would almost as soon believe that the cat curls the end of its

tail when preparing to spring in order to warn the doomed mouse. It is a much more probable view that the rattlesnake uses its rattle, the cobra expands its frill, and the puff adder swells while hissing so loudly and harshly, in order to alarm the many birds and beasts which are known to attack even the most venomous species. Snakes act on the same principle which makes a hen ruffle her feathers and expand her wings when a dog approaches her chickens." In this passage the writer commits himself to the view that the rattle is an instrument of intimidation. It may, however, be observed that the sound would be quite as likely to attract enemies as to repel them. Moreover, it is now a well-ascertained fact that rattlesnakes do not possess the power of hissing; and as that faculty seems more closely connected with



THE BUSHMASTER.
(One-sixth natural size.)

fear than with any other emotion, it would be quite reasonable to suppose that the rattle stands in place of the hiss. Another feature in the controversy is the circumstance that the sound of the rattle of one snake causes all its kindred within hearing to sound their own; and the organ therefore probably serves as a means of communication. What is known as the "dinner-bell" theory, that is, that a rattlesnake attracts insects like grasshoppers and cicadas within striking distance by the resemblance of the sound of its rattle to their own stridulating utterances, has been pretty clearly disproved; while if it required a further quietus, the circumstance that these reptiles do not appear to prey habitually upon insects would be sufficient. On the whole, while admitting that fear has probably some share in the matter, it

seems better to suspend our judgment before definitely committing ourselves to any one particular view. That rattlesnakes are some of the most deadly of all venomous serpents may be freely admitted; and it seems that we must almost concede that they possess the mysterious power of "fascinating" their victims before striking. Moreover, the assertions as to the power possessed by vipers of swallowing their young are equally numerous and well authenticated in the case of the serpents under consideration.

**The Bush-
master**

The formidable South-American snake (*Lachesis muta*) known to the Dutch settlers of Guiana as the bushmaster, but by the Brazilians termed the surukuku, differs from the rattlesnakes by the presence of a distinct keel-like ridge down the back, and, in place of a rattle, having the under surface of the tip of the tail covered with from ten to twelve transverse rows of small, spiny, sharp scales, while the extremity terminates in a spine. This snake attains a length of from nine to twelve feet, and has the ground color of the upper parts reddish yellow, upon which is a longitudinal row of large blackish brown lozenges, each having two light spots on either side of the middle line; while the under parts are yellowish white, with a porcelaneous glaze. The large size and enormous poison fangs of the bushmaster render it one of the most formidable of the pit vipers; its bite being apparently fatal to human beings in a few hours. Fortunately it is far from common, and inhabits only the secluded portions of the primeval forest, where it lies coiled up on the ground. Unlike most snakes, when disturbed it makes no attempt to flee, but strikes with the rapidity of lightning at the disturber of its slumbers.

Halys Vipers

These snakes have the upper surface of most, or all, of the front of the head covered with large shields; the body is rather long and clothed with from seventeen to twenty-seven rows of keeled scales; and the very short tail has its lower shields arranged in either a double or single series, some species having a small spine at the extremity, which is regarded as a rudimentary rattle. The genus is common to Asia and North and Central America; some half score of species being known, two of which are found in India. One species ranges as far east as the Urals, where it just enters the confines of Europe. In habits they are all terrestrial.

**Himalayan
Halys**

Of the Indian species, in both of which at least the majority of the shields on the lower surface of the tail are arranged in two rows, the Himalayan halys (*Ancistrodon himalayanus*) is distinguished by having two pairs of large shields on the muzzle, the extremity of which is but little turned upward. In color it is brown, with black spots or transverse bands, while sometimes a light festooned stripe runs down the back; from the eye to the angle of the mouth runs a black streak edged with white; and the under parts are either dark brown, or variegated with black and white. This snake, which grows to nearly a yard in length, is abundant in the Northwestern Himalayas, at elevations of between five thousand and eight thousand feet, although it sometimes ascends considerably higher. The carawila (*A. hypnale*) of Ceylon and Western India, is a much smaller species, not exceeding twenty inches in length, and characterized by the extremity of the upturned muzzle being covered with small scales.

Siberian Halys Somewhat superior in size to the common viper, this species (*A. halys*) may be recognized by the small portion of the head that is covered with shields, and also in that each shield, or pair of shields, overlaps with its hinder edge the shield immediately behind it, thus producing a more or less marked imbrication of the whole of the head shields. Another characteristic is to be found in the small size of the anterior frontal shields, which together have a crescentic shape and a somewhat saddle-shaped upper surface. The head is very distinctly defined from the compressed neck, the body being rather long, of a rounded triangular form in the middle, and covered with twenty-three rows of triangular scales; the very short tail, which is much thinner than the hinder part of the

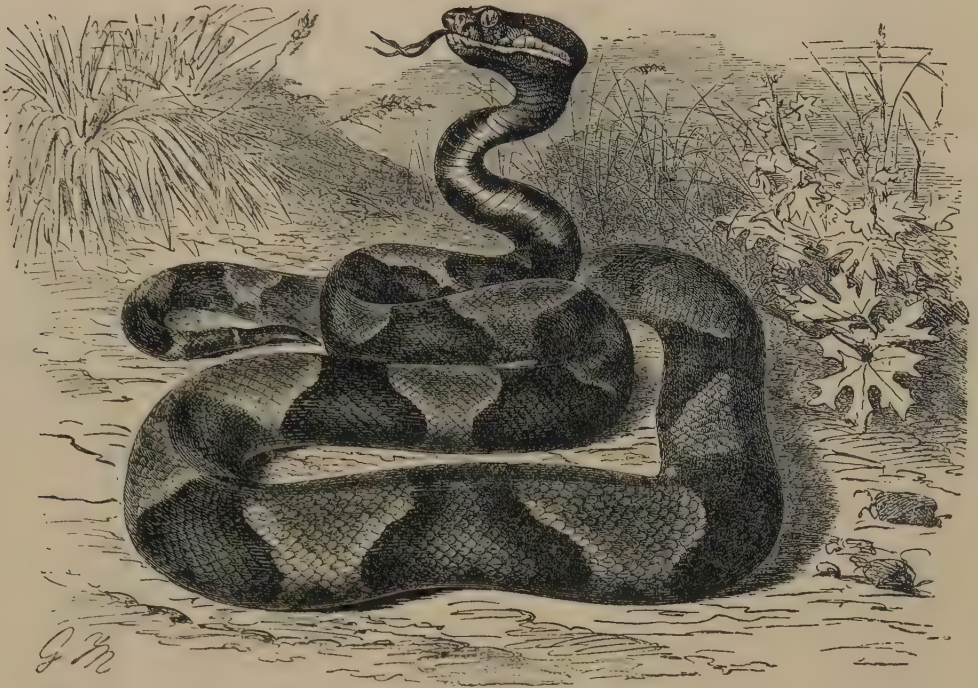


SIBERIAN HALYS VIPER.
(One-half natural size.)

body, is conical, and armed at the extremity with a forked horny appendage. The ground color of the middle of the back is a dark brownish yellow gray, while that of the under parts is a yellowish white, with more or less well-defined black spots on the hinder shields. The yellow ground of the labial shields of the head has chestnut-brown markings; and the crown of the head bears a large quadrangular blotch, forming an interrupted transverse band on the frontal shields, and a temporal band running from the hinder border of the eye to the angle of the mouth and the side of the neck. Somewhat similar markings ornament the back and are more or less clearly margined with yellow. Along the whole length of the back and the ridge of the tail are a number of yellowish or yellowish-white black-edged irregular blotches or cross bands; and on the sides are two rows of blackish brown

spots with white edges, which frequently run one into another, the first dark spot on the neck differing from the rest by its horseshoe form. The distributional area of this snake extends eastward from the Volga to the Yenisei. In Europe the halys viper inhabits the steppes between the Volga and the Urals, but its true home is Central Asia.

In North America, one of the best-known and most widely-distributed members of the genus is the copperhead, or moccasin snake (*A. contortrix*), which seldom much exceeds a yard in length. The body is strong and thick, the short tail provided with one row of shields infe-



COPPERHEAD OR MOCCASIN SNAKE.
(Two-fifths natural size.)

riorly and with a horny appendage at the end, while the elongated triangular head is markedly distinct from the neck, with the pits on the snout rather shallow, and the gape of the mouth very wide, and there are no small smooth shields behind the large parietals. A beautiful coppery brown, becoming lighter on the sides, forms the ground color of the upper parts, upon which some sixteen reddish brown dark-edged bands, becoming wider on the flanks, have given rise to the name of moccasin snake. On the under parts the shields are copper red, marked on the sides with large polygonal or rounded alternating dusky spots. The head is generally lighter colored than the body, and marked by a broad stripe running from the snout along the side to the angle of the mouth. The distribution of the copperhead extends

from the 45th parallel of north latitude to the extreme south of the Eastern United States. Its favorite haunts are damp situations, more especially shady meadows covered with tall grass; and its food consists of mice, birds, and probably frogs. From its abundance and comparatively rapid movements, as well as from its lacking the warning sound of the rattle, the copperhead is even more dreaded than the rattlesnake.

Water Viper Another well-known North-American representative of the genus that must come in for a brief share of attention is the water viper (*A. piscivorus*), which inhabits marshes, rivers, and lakes, and attains a length of nearly five feet. From the preceding species it may be distinguished by the pres-

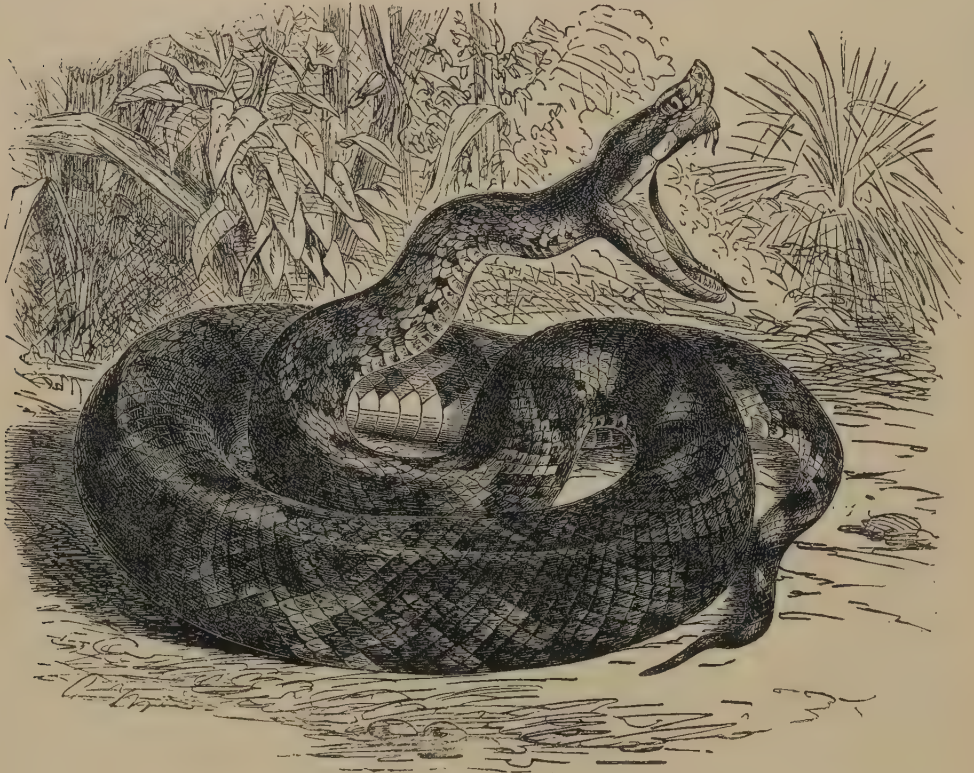


CLIMBING PIT VIPER.
(One-half natural size.)

ence of two small smooth supplemental shields behind the parietals, and of numerous small scales between the hinder frontal and temporal shields. The color is very variable; but in the majority of specimens, on a shining greenish gray ground, there are a larger or smaller number of dark bands somewhat similar to those of the copperhead. Always found in the neighborhood of water, this snake extends southward from North Carolina over the whole of North America and westward as far as the Rocky mountains. Feeding chiefly upon fish and frogs, it will also devour all animals that may happen to fall into the water and are not too large for its

maw; while in the rice fields it is the dread of the negroes. Not only is the water viper feared by man, but it is shunned by all animals dwelling in or near water.

Under this title may be included the members of the largest genus of the subfamily, which is likewise common to tropical America and Asia, and is the last group of snakes that we have space to mention. These pit vipers are long-bodied snakes, characterized by the whole of the upper surface of the triangular head being covered with scales instead of shields; the tail, which is frequently prehensile, ending in a sharp point, and having either one or



RAT-TAILED PIT VIPER.
(One-sixth natural size.)

two rows of shields on its lower surface. In all the Asiatic species there are two rows of these subcaudal shields, and it is only in a few of the New-World forms that they are reduced to a single series. The number of longitudinal rows of scales on the body is very variable in the different species, ranging from as few as thirteen to as many as thirty-one. In Asia these snakes range from India to the south of China and the Liu-Kiu islands; and while some species are terrestrial and normally colored, others are arboreal, and in the greenish tints assimilate to the color of their surroundings. The climbing tree viper (*Trimeresurus gramineus*) belongs to a group of four allied Indian and Burmese species, characterized by their

prehensile tails and the arrangement of the scales on the body in from thirteen to twenty-three rows; the figured species usually having twenty-one rows of scales, while there are from seven to thirteen scales in a transverse series on the head between the supraoculars; the temporal scales are smooth, and the shields on the lower surface of the tail vary in number from fifty-three to seventy-five. Attaining a length of two and one-half feet, this snake usually has the upper parts bright green, although in some specimens they may be yellowish, grayish, or purplish brown, while they may or may not be marked with black, brown, or reddish spots. Generally there is a light colored or reddish streak along the outer row of scales, and the end of the tail is frequently red or yellow, the under parts being green, yellow, or whitish. Ranging from Bengal to the Malayan region, this species is thoroughly arboreal in its habits. Stoliczka states that he found these snakes very common about the limestone hills near Moulmein, where they are exactly of the same green color as the foliage among which they hide themselves. He saw small specimens very often on low umbelliferous plants growing about a couple of feet high. One of the snakes had its tail wound below around the stem of the flower on the top of which it was basking. All were very sluggish and did not make the slightest attempt to escape when approached, and even allowed themselves to be removed from the top of the plant. Neither did they offer to bite, unless when pressed to the ground with a stick; but when thoroughly aroused, they turned round and bit furiously. The rat-tailed pit viper or fer-de-lance (*T. lanceolatus*) is one of several American species with nonprehensile pointed tails, whose habits are terrestrial. Reaching a length of nearly seven feet, with a body as thick as a man's arm, this snake is very variable in coloration, the ground color of the upper parts being generally a reddish yellow brown. The distinctive markings take the form of a black stripe, which is but seldom absent, running from the eye to the neck, and of two rows of irregular dark cross bands on the body. In some specimens the sides of the body are, however, of a bright red. The form and arrangement of the scales on the head, the presence of seven upper labial shields, and the arrangement of the body scales in not more than twenty-nine rows, together with the uniformly-colored under surface of the body, serve to distinguish the species from its congeners. This snake is an inhabitant of the Antilles and Central America. During the daytime it lies curled up in repose within the middle of the coils of the body, ready to dart out with the rapidity of lightning on the approach of an enemy.

Jararaca The mainland of South America is the home of the two closely-allied terrestrial representatives of the genus, respectively known as the jararaca (*T. jararaca*) and the labaria (*T. atrox*), which are exceedingly difficult to distinguish from one another. The former, which ranges from Amazonia southward to San Paulo and westward to Ecuador and Peru, has eight or nine upper labial shields on the snout, and from twenty-five to twenty-seven rows of scales on the body; the general color of the upper parts being gray or grayish brown, with small dark brown cross bands, bordered by darker edges, while the under parts are gray, with two or four irregular longitudinal rows of whitish or yellowish spots. The labaria differs in having only seven upper labials, as well as in certain details

of coloration, the back showing dark lozenges alternating with X-shaped markings, while the under parts are darker, with sometimes two rows of white spots, and from the eye to the corner of the mouth runs a broader dark brown stripe. Inhabiting Eastern Brazil, this species extends as far north as Guiana, while its southward range is less than that of the jararaca.

Writing of the latter, Bates states that in Brazil it is far more dreaded than the jaguar or the alligator. "The individual seen by Lino lay coiled up at the foot of a tree, and was scarcely distinguishable, on account of the colors of its body being assimilated to those of the fallen leaves. Its hideous, flat, triangular head, connected with the body by a thin neck, was reared and turned toward us; Frazao killed it with a charge of shot, shattering it completely, and destroying its value as a specimen. In conversing on the subject of jararaca as we walked onward, every one of the party was ready to swear that this snake attacks man without provocation, leaping toward him from a considerable distance when he approaches. I met, in the course of my daily rambles through the woods, many jararacas, and once or twice very narrowly escaped treading on them, but never saw them attempt to spring. On some subjects the testimony of the natives of a wild country is utterly worthless. The bite of the jararacas is generally fatal."

EXTINCT GROUPS OF SCALED REPTILES

A brief reference may be made to two groups of extinct reptiles from the rocks of the Secondary epoch, which must be included in the order Squamata.

Long-Necked Lizards The first of these groups is represented by a small snake lizard, from the English Chalk, described under the name of *Dolichosaurus*, and forming a suborder (Dolichosauria) by itself. Whereas ordinary lizards have not more than nine vertebræ in the neck, this strange reptile has upward of from fifteen to seventeen, while its hind-limbs are characterized by having the whole of the five metatarsal bones of the foot well developed, and its whole structure reveals a very generalized type of organization. The vertebræ have additional articulations like those of snakes. It is probable that these reptiles form the ancestral group from which the other suborders of scaled reptiles have originated.

Cretaceous Sea Serpents A still more remarkable group of the order is formed by certain carnivorous marine reptiles from the Cretaceous rocks, many of which attained gigantic dimensions, and may not inappropriately be designated extinct sea serpents. Commonly known as Mosasauroids, on account of the first described genus (*Mosasaurus*), having been found on the banks of the Meuse, they form a suborder technically known as the Pythonomorpha. They all had a much elongated body, and a skull approximating in structure to that of the monitors among existing lizards, the nasal and premaxillary bones being welded together, and the quadrate very loosely attached to the skull. Teeth were present on some of the bones of the palate, as well as on the margin of the jaws; those of the latter series being large, sharply pointed, and attached by

expanded bases. The bones of the shoulder girdle and pelvis were more or less imperfectly developed, and the limbs were modified into paddles or flippers, with the toes inclosed in a common skin, and devoid of claws. There were either nine or ten vertebræ in the neck; and whereas, in some cases, the vertebræ resembled those of snakes, in other instances they lacked the additional articulations distinguishing the latter. It will be unnecessary to particularize the various genera of these reptiles, but it may be mentioned that while some of the better-known forms have been described as *Mosasaurus*, others have received the names of *Liodon* and *Clidastes*. They appear to have inhabited the Cretaceous seas of all parts of the world, having been obtained from regions as far apart as England, New Zealand, and Argentina; and while some attained a length of between twenty-five and thirty feet, others were not more than eight or ten. Then, again, while in some cases the jaws were armed with powerful teeth to their extremities, other forms had a long, toothless beak.

CHAPTER VI

THE REMAINING GROUPS OF REPTILES—ORDERS ICHTHYOPTERYGIA, RHYNCHOCEPHALIA, AND ANOMODONTIA

OF THE three orders remaining for consideration, two are completely extinct, and not known from deposits of later date than those of the Secondary period, while the third is represented at the present day only by a single species from New Zealand, although in former geological epochs it appears to have been abundant. The first of the three for consideration is the group of

FISH LIZARDS—Order ICHTHYOPTERYGIA

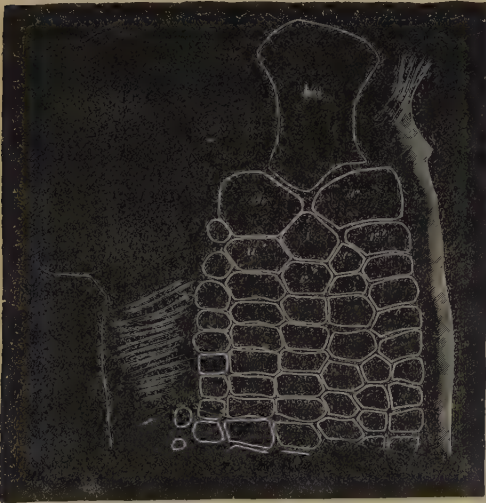
More or less familiar to all from the beautifully preserved skeletons obtained from the Lias of England and the Continent, specimens of which are exhibited in almost every museum, the Fish Lizards, or Ichthyosaurs, were large marine reptiles, with the naked body thick and whale-like, the neck extremely short, and the limbs modified into paddles differing from those of all other members of the class in the structure of their skeleton. The skull is produced into a long snout, generally furnished with a full series of sharp teeth, and mainly formed in the upper jaw by the premaxillary, or front jawbones; and the nostrils are consequently placed close to the eyes, the latter, like those of birds, being provided with a ring of movable plates. Superiorly, the skull has a hole or foramen in the parietal bones; while posteriorly the upper and lower arches are connected behind the socket of the eye by a bone known as the supratemporal, so that this portion of the skull is completely roofed over, as we shall see to be the case in the Labyrinthodont Amphibians. Then, again, the quadrate bone, with which the lower jaw articulates, is firmly united to the adjacent elements of the skull; while in the general relations of this bone and the bones of the palate there is a marked agreement with the beaked reptiles. The teeth are confined to the edges of the jaws, where they are implanted in distinct sockets, and generally have conical and fluted crowns, although more rarely they are compressed and smooth, with sharp cutting edges at the front and back. The backbone presents a nearly similar structure, the vertebræ, as shown in the figure on p. 2362, being short discs, which may be either deeply cupped or nearly flat at the two ends. In the body and neck these vertebræ carry a pair of tubercles on each side for the articulation of the forked ends of the ribs; but in the tail there is but one such tubercle, the ribs being single headed. Moreover, the vertebræ are further remarkable for the absence of any bony union between the body or centrum (the part represented in the figure) and the arch inclosing the

spinal marrow, so that these two portions are always found detached. The bones of the shoulder girdle much resemble those of lizards, the collar bones being well developed, and the T-shaped interclavicle resting on the lower surface of these and the metacoracoids. The limbs are quite unlike those of any other reptiles, the upper bone (humerus in the fore-limb) being very short and thick, while below this the whole of the bones, as shown in the accompanying figure, were polygonal, and so articulated with one another that the skeleton of the paddles assumed a



SKELETON OF FISH LIZARD, SHOWING YOUNG ONE WITHIN THE CAVITY OF THE RIBS.
(One-fourteenth natural size.)
(From Gaudry.)

kind of pavement-like or mosaic structure. In most kinds the front paddles were much larger than the hinder pair; and whereas, in some cases, two longitudinal series of bones originate from the bone marked *i* in the accompanying figure, thus



PART OF THE FORE PADDLE OF A FISH LIZARD.

hu. bone of upper arm; *r. u.* bones of fore-arm; the other letters indicate the bones of the wrist, below which are the bones of the fingers.

producing a very broad type of paddle, in other forms (as shown in the skeleton in the figure above), only a single series articulated with that bone, and the whole paddle was consequently much narrower. Specimens like the one figured here show that while the soft parts of the paddle extended but a short distance in advance of the front edge of the bones, on the hinder side they terminated in a wide fringe, thus forming a structure admirably adapted for swimming. Other examples indicate that the back of these reptiles was furnished with an upright triangular fin somewhat like that of a porpoise, behind which were a number of small finlets, while the extremity of the tail was expanded into a horizontal fin, comparable to the flukes of a whale.

Many of these reptiles attained a length of from thirty to forty feet; and they flourished throughout the whole of the Secondary period, that is to say, from the epoch of the Trias or Red Sandstone to that of the Chalk, most or all of the forms from the first-named deposits being of a more generalized type than those of later date.

In external appearance the fish lizards must have presented a marked resemblance to whales, the place of which they seem to have filled in the old seas. Like these animals, they were obliged to come periodically to the surface of the water for the purpose of breathing; and they were likewise carnivorous, as is attested not only by the conformation of their teeth, but likewise by the petrified remains of their prey. Occasionally specimens are met with, in which entire skeletons of one or more young individuals of the same species are preserved within the cavity of the ribs, thus proving that in these reptiles the eggs were hatched within the body of the females, and the offspring produced in a living condition.

THE BEAKED LIZARDS

Order RHYNCHOCEPHALIA

The tuatera, which seems to be confined to the small islands off the northeast of New Zealand, is not only the most remarkable of all existing reptiles to which the term lizard can be applied, but is the sole living representative of a distinct family, as well as of an entire order; and the difference between it and an ordinary lizard immeasurably exceeds that by which the latter is separated from a serpent. As an order, the beaked reptiles may be provisionally characterized as follows: Externally most of these reptiles appear to have been more or less lizard-like; and, as in their living representative, the body was probably covered above with small granular scales intermingled with tubercles. The skull differs essentially from that of lizards in having the quadrate bone immovably fixed by the upper end to the adjacent bones, and likewise by having both an upper and a lower temporal arch. The hind portion of the palate is formed by the union of the pterygoid bones, which, generally at least, extend forward to meet the vomers, and thus divide the palatines; while the anterior upper jawbones or premaxillæ remain separate from each other. The teeth are not implanted in distinct sockets, and are usually welded to the summits of the jaws. In the trunk the ribs articulate to the vertebræ by single heads, and may have hook-like processes similar to those of birds; while on the lower surface of the body so-called abdominal ribs are always developed, forming a shield composed of a number of segments, and comparable to the plastron of the tortoises. The vertebræ may be either hollowed at both articular ends, or the hinder surface may be cupped and the front one ball-like. That the beaked reptiles form a very primitive group is clear, not only from their structure, but from their antiquity; representatives of the order occurring in the Permian strata, immediately overlying the Carboniferous or coal-bearing rocks. While some

of these early forms appear to connect the order very closely with the Sauropterygians, others indicate an equally close relationship with the under-mentioned Anomodonts.

The single existing representative of the order (*Sphenodon punctatus*) forms a family (*Sphenodontidæ*) by itself, and likewise is the representative of a distinct suborder (*Rhynchocephalia Vera*), characterized by each segment of the shield on the lower surface of the body being formed of only three elements, of which the middle one is chevron shaped, and likewise by the fifth metatarsal bone of the hind-foot being reduced in length and thickened in the same manner as in lizards. The group is further characterized by the double nos-



NEW ZEALAND TUATERA.
(One-fourth natural size.)

trils, the union of the two branches of the lower jaw by cartilage, and the deeply-hollowed articular surfaces of the vertebræ. From its extinct allies the family is distinguished by having a perforation on each side of the lower extremity of the humerus or upper bone of the fore-limb; by the presence of hook-like processes to the ribs, as well as of so-called intercentra, or additional segments between the bodies of the vertebræ; and likewise by the beak-like premaxillary bones carrying a pair of somewhat chisel-like teeth, and the presence of only a single row of teeth on the palate, which are separated by a groove from the the row affixed to the edge of the upper jaw. Into this groove is received the teeth and upper edge of the lower jaw, which in very old individuals becomes as hard and polished as the teeth themselves,

the latter being more or less completely worn away in extreme old age. On the upper surface of the skull is a large vacuity or foramen in the parietal bones. In external appearance the tuatera is lizard-like, the body being slightly and the long tail strongly compressed; the limbs carry five toes, all furnished with claws, and connected at their bases by webs. There is no external opening to the ear, and the large eye has the pupil vertical. On the upper parts the creature is clothed with small granular scales, intermixed with tubercles; and a crest of spine-like scales runs from the hinder part of the head down the middle of the back, continued in a smaller degree of development down the tail; while inferiorly there are large squarish scales arranged in transverse rows. Attaining a length of about twenty inches, the tuatera is olive or blackish in ground color, upon which are small yellowish dots, and the lobes of the crest on the neck and back are likewise of the latter color. The perforation in the parietal bones of the skull just referred to covers a rudimentary eye, which, although now functionless, was probably a working organ in the ancestors of the Vertebrates. In the young tuatera this pineal eye can be seen through the translucent skin, but in the adult this skin becomes opaque.



SKULL OF THE *Hyperodapedon*.
(One-fourth natural size.)

The upper figure shows the superior aspect; the lower one on the left the palate, and the right lower one the under surface of the front of the lower jaw.

the palate having two or more longitudinal rows of teeth separated by a groove. From the preceding families these reptiles differ by having only a single aperture to the nostrils, and by the bony union of the two branches of the lower jaw; while the articular surfaces of the vertebræ are nearly flat. Moreover, there is no vacuity in the middle of the top of the skull. In the typical genus there is a single row of teeth on the inner side of the groove on the palate, but in the *Hyperodapedon* there were numerous rows, as is shown in the illustration. The extremity of the beak in each jaw formed two curved tusk-like processes, which diverged in the lower one.

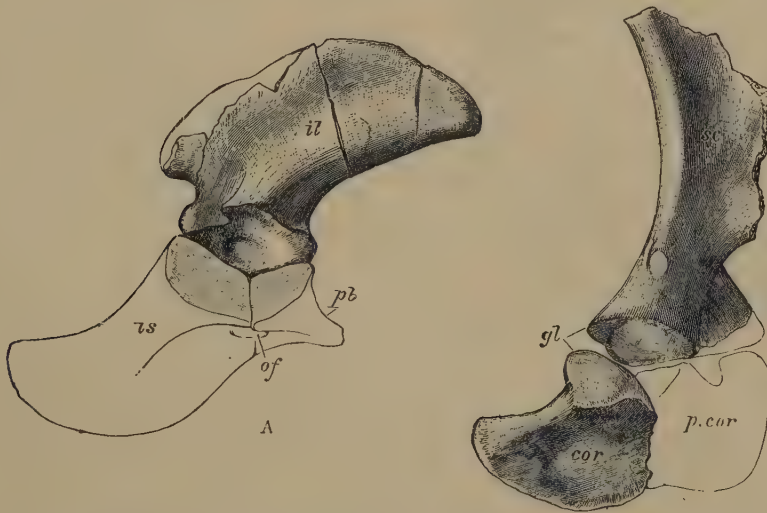
In the Jurassic rocks of Allied Families Europe there occur remains of reptiles allied to the tuatera, but constituting a distinct family (*Homæosauridæ*) typically represented by the genus *Homæosaurus*. These have no tusk-like teeth in the front of the jaws, and the lower end of the humerus has a perforation only on its inner side, and there are no intercentra between the vertebræ of the back, and no hook-like processes to the ribs. A third family (*Rhynchosauridæ*) is typified by the genus *Rhynchosaurus* from the Trias or New Red Sandstone of England, and is characterized by the beak being toothless and probably sheathed in horn;

Oldest Types The Permian rocks of Europe yield remains of genera, such as *Proterosaurus* and *Palæohatteria*, differing markedly from the foregoing, and constituting a second suborder (Proterosauria), characterized by the complex nature of the bones forming the shield on the lower surface of the body, by the fifth metatarsal bone of the hind-foot being of an ordinary type, and likewise by the lower bones of the pelvis being expanded into large flattened plates, instead of comparatively narrow. The last feature allies the group to the earlier Sauroptrygians. In the genus first named the vertebræ of the neck have cup-shaped articular surfaces behind and balls in front, and there are no intercentra between the vertebræ of the back, but in the other the articular surfaces of the vertebræ are slightly cupped at each end throughout the series, and intercentra are present.

THE ANOMODONTS OR MAMMAL-LIKE REPTILES

Order ANOMODONTIA

The last order of Reptiles, which is entirely extinct and confined to the Triassic and Permian epochs, is of especial interest to the evolutionist as being nearly allied to the ancestral stock from which Mammals have originated, and also



THE RIGHT SIDE OF THE PELVIS (A) AND SHOULDER GIRDLE (B) OF AN ANOMODONT.

il. haunch bone or ilium; *is.* ischium; *pb.* pubis; *of.* foramen between ischium and pubis; *sc.* blade bone or scapula; *p.cor.* coracoid; *cor.* metacoracoid; *gl.* cavity for head of upper arm bone or humerus.

equally closely related to certain extinct Amphibians noticed in the sequel, which were themselves evidently not far removed from the type whence sprang both Reptiles and Mammals. It should be observed, however, that these Anomodonts

show the nearest relationship to the Egg-laying Mammals, and until we know the true affinity of the latter to the other members of the same class, it is of course impossible to attempt to define the genealogy more exactly. The Anomodonts are the only reptiles which agree with the Egg-laying Mammals in having three distinct bones on each side of the true shoulder-girdle; that is to say, a blade bone, or scapula, above, and a coracoid and metacoracoid below. Then the pelvis is very mammal-like, not only in that its three elements are united, but likewise in the small size of the vacuity, or foramen (*of*) between the pubis and ischium. It will also be seen from the two figures here given how close is the resemblance between the pelvis and shoulder girdle of these reptiles, each having one bone above and two below. Even still more marked is the similarity between the upper arm bone or humerus of the Anomodonts and that of the Egg-laying Mammals; each having a perforation on the inner border of the lower end, whereas in those existing reptiles which possess such a perforation (with the exception of the tuatera, where there is one on each side), it is situated on the outer border. As a rule, the Anomodonts further resemble Mammals in the absence of abdominal ribs; and there are important similarities in the structure of the skull.

Anomodonts are met with in the Triassic rocks, and are represented by at least four well-marked subordinal types. In the first group, known as Mammal-



UPPER SURFACE OF THE SKULL OF A
PAVEMENT-TOOTHED ANOMODONT.
(One-third natural size.)



SKULL AND TEETH OF GALESUR.

toothed (Theriodont) Reptiles, the teeth, as exemplified in the figure of the skull of the African galesaur, are differentiated into incisors, tusks, and cheek teeth; the latter frequently having three cusps ranged in a longitudinal series. Whether, however, this marked mammalian type of dentition is indicative of genetic affinity

with Mammals, may be opened to doubt, as it is quite as likely to be due to parallelism in development. Another modification is presented by the Dicynodonts of England, Africa, and India, in which the jaws formed a horny beak, either destitute of teeth, as in the tortoises, or provided with a huge pair of tusks in the upper jaw; some of these reptiles being of gigantic size. A third group, known as Pavement-toothed, or Placodont Reptiles, which should probably be included in the order, are characterized by the presence of broad, flattened teeth on the palate and jaws, as shown in the figure on p. 2361; the skull being very short and more or less

triangular, with the double nostrils situated near the extremity of the muzzle, some distance in advance of the sockets of the eyes, which occupy a nearly central position. In all these forms, the skull has large temporal fossæ in the hinder part of the upper surface; but in the Wall-toothed or Pariasaurian Anomodonts, as shown in the cut, the hinder part of the skull was roofed over by bone, in the manner characterizing the Labyrinthodont Amphibians, to which these reptiles were allied; a peculiar sculpturing of the surface of the skull being another point of resemblance. In the series, of which the skull is figured, a number of spines surmounted the head; but these were wanting in the African pariasaur, which was a gigantic creature, with a somewhat frog-like head, an apology for a tail, and powerful short limbs, in which the toes were armed with long claws.



UPPER SURFACE OF THE SKULL OF A
WALL-TOOTHED ANOMODONT.
(One-fourth natural size.)



FIRE-BELLIED FROGS.
(Natural size.)

AMPHIBIANS

CHAPTER I

GENERAL CHARACTERISTICS — Class **Amphibia**

FROGS AND TOADS — ORDER ECAUDATA

IN POPULAR estimation frogs and toads together with their near relatives the newts and salamanders, are regarded as Reptiles, but they are really very different, and constitute a class by themselves, being in many respects intermediate between Reptiles and Fishes. From the mode of life of its members the very appropriate name of Amphibians has been proposed for the class, and is the one which should be adopted, although the term Batrachians, which more properly applies to frogs and toads alone, is not unfrequently used in the same sense. Agreeing with the higher Vertebrates in the structure of their limbs, which are divided into the same number of segments as in Mammals and Reptiles, and supported by corresponding bones, existing Amphibians are distinguished from Reptiles by the absence of any ossification in the basioccipital region of the lower surface of the hinder part of the skull, in consequence of which the latter is articulated to the first vertebra by means of two condyles formed exclusively by the occipital bones. A further important point of distinction is afforded by the absence in the embryo of those membranous structures known as the amnion and allantois. Moreover, the great majority of

Amphibians pass through a metamorphosis, or rather a series of metamorphoses, commencing their existence immediately after leaving the egg in a larval condition, during which they breathe the air contained in water by means of gills, while in the adult state they breathe atmospheric air by means of lungs. Varying much in external form, these animals nearly always have the body covered with a soft naked skin; but in a few instances among existing forms scales are imbedded in the skin, and most of the extinct forms had a well-developed armor of scales and bony scutes. In some forms a longitudinal fin is developed down the middle of the back and tail, but this is always soft, and lacks the supporting spinous bones characterizing that appendage in fishes. In passing through a metamorphosis, Amphibians are more like the inferior groups of animals than the higher Vertebrates; and while in the earlier stages of their existence, during which they breathe by gills, they may be regarded as very closely allied to Fishes, in the adult state they come much nearer to Reptiles. The extinct Labyrinthodonts, which are themselves not very widely removed from fishes, and have the basioccipital bone ossified, serve to connect other members of the class with the Anomodont and Beaked Reptiles. And it may be mentioned here that while in Mammals the skull has continued to be supported by the two condyles of the Amphibians, in the Reptiles the basioccipital bone has developed an intermediate condyle filling up the gap between the two exoccipital condyles, and thus forms a single tripartite condyle like that of the tortoises. Frequently, as in the crocodiles, the lateral elements have tended more or less completely to disappear, thus leaving a condyle formed almost entirely by the basioccipital.

Skin

As already said, the skin of most existing Amphibians is soft and naked; it is invested with a colorless epidermis, which is periodically shed entire, while the deeper layer is often colored with blotches or streaks of yellow, red, brown, or black. Other colors, however, such as green and blue, are produced by pigment cells, which generally make their appearance under special conditions of warmth and moisture. As a rule, the color of Amphibians varies to a great extent with the nature of their surroundings, as is well exemplified in the case of the frog, which changes its hue according to the nature of its habitat; while the tree frogs harmonize with the foliage among which they dwell. It is, however, very remarkable that in Costa Rica a certain toad simulates to an extraordinary degree the coloration of the snakes — both poisonous and harmless — of the same country; while in North Sumatra Amphibians of various groups are spotted with carmine red. In all Amphibians the skin is furnished with glands secreting a more or less milk-like fluid; these glands being generally distributed all over the body, although sometimes they are confined to the sides of the neck behind the eyes. In many toads and land salamanders some of the larger glands appear as prominent warts, pierced with large pores. The viscid, milky fluid secreted by these glands is exuded during excitement, and is endowed with more or less poisonous properties, being intended to serve as a means of defense. Although some degree of irritation of the skin may be produced by handling some of the species in which these poisonous properties are most developed, the stories of toads or salamanders spitting venom are, it is almost needless to observe, pure fabrications. When introduced

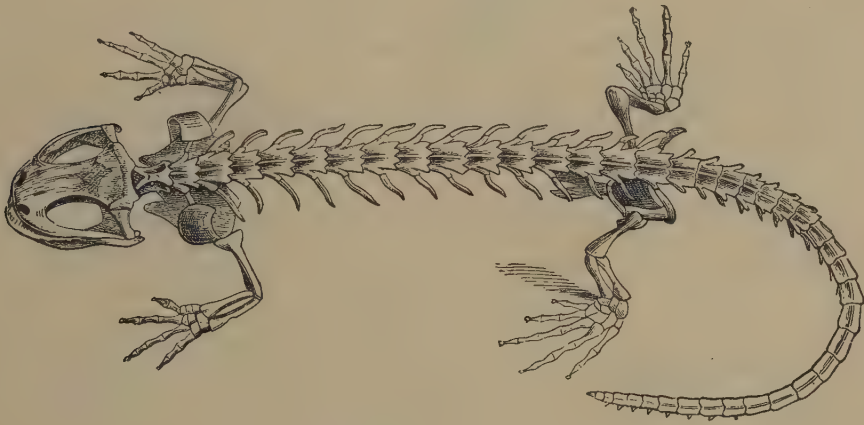
into the circulation, batrachian venom acts, however, as a powerful poison, influencing the heart and central nervous system; and the secretion of a South-American species is employed by the Indians to poison spears and arrows used in killing monkeys.



BULL FROGS DISPORTING.

In the economy of Amphibians the naked skin and its glands play a most important part, since none of them drink, in the proper sense of the word, but imbibe moisture through the pores of their integument. Moisture is, indeed, essential to their existence, and if they be confined in a dry atmosphere they soon perish. It is true that frogs may be seen basking in the sun's rays, and apparently enjoying the warmth as much as lizards, but they only do this in the neighborhood of water, to which they retire when necessary. Such members of the class as inhabit dry localities, are mostly nocturnal, avoiding sunshine, and wandering abroad when they can obtain moisture from dew.

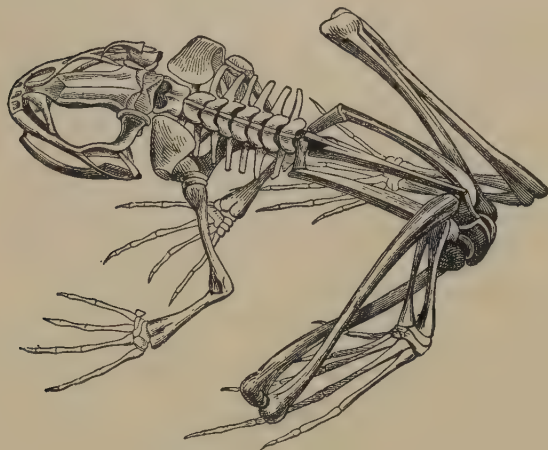
Skeleton The skeleton of the Amphibians presents many peculiarities, and in some forms has numerous fish-like characteristics. For instance, in certain of the forms with permanent gills the vertebræ are scarcely distinguishable from those of fishes; whereas in the true newts they have a rounded knob at the front of the body and cup at the hinder extremity, and are closely articulated with



SKELETON OF SALAMANDER.

one another. In the long-tailed groups the number of vertebræ is considerable; but in the frogs and toads those of the back are reduced to seven or eight, the hinder end of the backbone terminating in a long style extending between the greatly produced extremities of the haunch bones, or ilia, which articulate with the lateral processes of the sacral vertebræ. The transverse processes of all the vertebræ are well developed, and in some cases very long; and they take the place of ribs, which, at the most, are represented by some small rudiments. In consequence of this absence of ribs, Amphibians are unable to breathe in the ordinary way by alternate expansion and contraction of the cavity of the chest, and they, so to speak, swallow air, taking in a large gulp, and then closing the mouth. In addition to the peculiarities connected with its condyles and the basioccipital region, the skull is distinguished by its flattened, broad, and more or less semicircular form; the sockets for the eyes being generally large and ill-defined. In front of the condyles the under surface of the middle of the skull is overlain by a large parasphenoid bone, which is frequently dagger shaped; this bone being

generally but slightly, if at all, developed in the higher Vertebrates, although very large in Fishes. The lower jaw, which articulates with the skull by the intervention of a quadrate bone, is composed of at least two pieces on each side and may contain more elements. The palatines and vomer, and more rarely the parasphenoid, may be armed with teeth, like the upper jaw; but in the frogs and toads the lower jaw is very generally toothless. In all cases the teeth are small, simple, and pointed; being adapted for holding and not for masticating; The shoulder girdle, which is



SKELETON OF FROG.

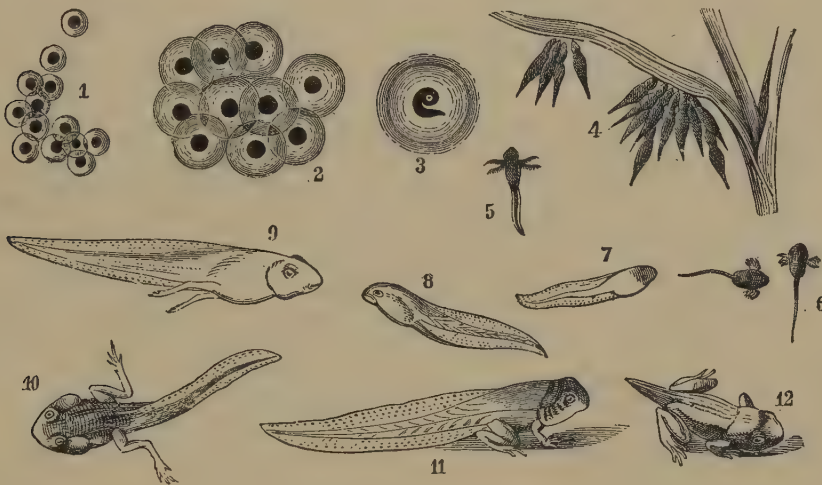
largely cartilaginous, is placed very close to the head, and comprises the usual elements. Each scapula, or shoulder blade, has an upper cartilaginous portion extending inward nearly to the middle line of the back; while in the frogs each metacoracoid has an inward cartilaginous expansion, which may either meet or overlap its fellow, and is of much importance in classification. In advance of the metacoracoids is another pair of transverse bars commonly known as the precoracoids; while in front of these is a single median rod termed the

omosternum; the proper sternum, or breastbone, occupying a similar position behind the metacoracoids. In the fore-limb the radius and ulna may be united, and the wrist cartilaginous; the number of toes among living forms never exceeding four, and being sometimes reduced to three. More variation exists in the hind-foot, the number of toes in the long-tailed forms ranging from two to four, whereas in the frogs and toads it is always five. Only in a few frogs and newts are the toes furnished with claw-like nails; in the greater number of forms these being naked, although often connected by webs, and sometimes carrying adhesive discs on the lower surface.

Soft Parts In all Amphibians the brain is of a very low type, its component portions lying in a line one behind the other, without overlapping. All possess the three chief organs of sense, although in some instances the eyes may be very minute and covered with an opaque skin. In frogs and toads the eye is large and very highly developed; generally possessing two lids of which the lower one is larger and thinner than the upper, and more or less transparent. Greater variation exists in the structure of the ear, which is simplest in the tailed forms. The nose opens externally in a pair of nostrils situated near the muzzle, and by another pair of apertures into the mouth; the latter characteristic distinguishing Amphibians from the majority of Fishes. The tongue, which acts only in the very slightest degree as an organ of taste, and is wanting in one group of frogs, is generally well developed and thick, filling the whole space between the jaws, and being

capable of a large amount of motion; it differs essentially from that of the higher Vertebrates in that it is affixed to the inner side of the front of the lower jaw, with its tip pointing down the throat.

Development All Amphibians lay eggs, which are generally although not invariably deposited in fresh water, and fertilized as they are extruded from the female. As a rule, these eggs,, which much resemble those of fish, are small, very numerous, and connected by mucilage, forming either a string or a jelly-like mass in which the dark yolks are very conspicuous. Some of the tree frogs, however, lay large eggs, within which the larvæ undergo the whole of such transformation as takes place; and in one genus, instead of the usual gills, a temporary breathing organ is developed on the tail. A land frog in the Solomon islands also lays large eggs, like small marbles, which are deposited in the crevices



DEVELOPMENT OF THE FROG.

1. Eggs when first laid; 2. Eggs at a later stage; 3. Egg containing embryo; 4. Newly-hatched larvæ; 5, 6. Larvæ with external gills; 7-12. Later stages in the development of larvæ.

of the rocks, and from which emerge fully-developed frogs. The eggs, with certain exceptions, are deposited in water, where they are hatched by the heat of the sun; and it appears that the dark color of the yolk is for the purpose of absorbing as much solar heat as possible. Such eggs as are laid during the late spring and summer are less darkly colored, and have thinner coats, than those deposited in the early part of the spring; and while the former are placed on the ground at the bottom of the water, the latter float on the surface; the reason of this difference being that in the early part of the year the lower strata of water are too cold to admit of the development of the ova. In ordinary cases, when the larva has reached a certain stage, it bursts the investing membranes of the egg, and comes into the world adapted for an aquatic life, and always possessing a long compressed tail composed of zigzag-shaped masses of muscles, similar to those of fishes. The

first process is the sprouting forth of branching external gills from the sides of the neck, which in the larvæ of the frogs and toads are subsequently replaced by internal gills, but in the long-tailed forms persist for a longer period. After the disappearance of the external gills, the water is expelled from the gill chamber by one or two tubes, generally discharging by a single orifice, which may be situated either on the lower surface of the body, or on the left side. As soon as the external gills have made their appearance, development is concentrated on the tail, and the absorption of the remainder of the yolk. The vertical fin-like expansion of the tail rapidly increase, and the body becomes relatively smaller and more slender, while the limbs begin to make their appearance as buds, although the date of development of the front and hind pair varies in different groups. In the newts, the front pair of limbs are the first to appear, in the frogs the reverse is the case. In the latter the hind-limbs appear some considerable time before the front pair, the fish-like tail persisting till the sprouting of these, when the change from a herbivorous fish-like animal to one carnivorous and reptiliform begins. The jaws are at first invested with horny teeth, and subsequently with horny sheaths, which eventually disappear; while the tail gradually diminishes in size, and finally is lost. It may be observed that no vertebræ are developed in the frog's tail; and that the long spine in which the backbone of the adult terminates is an outgrowth from the hindmost vertebra. Not less remarkable is the shortening of the intestinal canal, as the creature changes its herbivorous for carnivorous habits. To trace in detail the development of the soft parts would greatly exceed our limits of space. We may mention, however, that in one group of the Tailed Amphibians the external gills of some individuals may be retained permanently, while in others of the same species they are cast at an early period. Then again, the number of these gills is by no means constant, for in the Cingalese cæcilian and the salamander there are three pairs of these organs, in the tadpoles of some frogs there are two, and in others, as well as in one genus of cæcilians, there are only a single pair.

Distribution Geologically the Amphibians are a very ancient group, their oldest representatives occurring in the Carboniferous and Permian rocks of Europe and North America. All these ancient representatives of the class belong, however, to the group of Labyrinthodonts, which survived till the period of the Trias, and are structurally very different from the modern forms, approximating in certain respects to fishes. Indeed, since no Amphibians have hitherto been discovered between the Trias and the Wealden, or lower Cretaceous, rocks of Belgium, we are quite unable to assert that the modern representatives of the class are the direct descendants of the Labyrinthodonts. Commencing in the Belgian Wealden, the newts and salamanders occur throughout the greater part of the Tertiary rocks; but the frogs and toads are first known in North America from Eocene beds; while in Europe they are not met with before the Oligocene.

At the present time Amphibians are distributed over all parts of the world except the polar regions; although they are more dependent upon the presence of water and warmth than any of the preceding classes of Vertebrates. They are, accordingly, most abundant in the tropical and subtropical regions; and as none of them are marine in their habits, even a narrow arm of the sea is generally sufficient

to limit their habitat. When they occur on islands, it is probable either that their eggs have been carried by birds, or that there has been a comparatively recent separation from the mainland. In absolutely desert districts Amphibians are unknown; while in countries where there is a long dry season, followed by a period of rains, they are in the habit of becoming torpid during the former; the length of the sleep in one Javan species being upward of five months. In cold climates all the members of the class become torpid during the winter. As regards their general distribution, Amphibians closely resemble fresh-water fish, and differ widely from lizards. Indeed, from an Amphibian point of view, the globe may be divided into two great regions, namely, a northern one characterized by the abundance of newts and sala-



MOOR FROGS.
(Natural size.)

manders, and the absence of cæcilians; and a southern one distinguished by the want of the former and the presence of the latter group.

Habits

In their mode of life, it is probable that very few Amphibians are diurnal; most of the terrestrial forms making their appearance abroad with the first shades of evening, and retiring to their hiding places at dawn. In wet or cloudy weather frogs and toads — especially in South America — frequently appear in great numbers during the day; and both these groups are in the habit of making night hideous with their croakings. Although in all cases the adults are carnivorous, the larvæ subsist more or less exclusively on vegetable substances; some confining themselves to that kind of diet, while others also consume animalcules and other minute creatures.

The frogs and toads are distinguished from their allies by the presence of four limbs and the absence of a tail in the adult state; the latter feature giving origin to the name Ecaudata, by which the order to which they belong is scientifically designated. They all have short and frequently thick bodies, in which the backbone comprises, at most, only eight vertebræ in advance of the sacrum; those behind the latter being fused into a long rod-like bone, as shown in the figure of the skeleton on p. 2626. In the fore-limb, as shown in the same figure, the bones of the fore-arm (radius and ulna) are completely fused together; and the same is the case with regard to the tibia and fibula in the hind-leg. Moreover, the hind-limb obtains a kind of additional segment, owing to the elongation of the calcaneum and astragalus in the ankle joint, which form a pair of long bones lying parallel to one another. As a rule, frogs and toads undergo a lengthened larval period; the "tadpoles," as shown in the figure on p. 2627, having a globular head and body, a fish-like tail, external or internal gills, and no limbs in the first stages of their existence. The hind-limbs are the first to appear, and after the front pair are developed the tail is gradually absorbed upon which the young for the first time leave the water. Represented by about a thousand species, frogs and toads have a world-wide distribution, although more abundant in tropical and subtropical than in temperate regions, and being especially numerous in India and South America; and it is not a little remarkable that some of the largest forms are inhabitants of islands. From the nocturnal habits of the adults it is frequently difficult to find out whether in any locality these reptiles are abundant or the reverse; but in the spring this may generally be ascertained by observing the tadpoles in the rivers and points.

THE TYPICAL FROGS

Family *RANIDÆ*

The typical frogs, together with four other families, constitute a suborder (Firmisternia) characterized by the presence of a tongue, and by the firm union of the two metacoracoid bones of the chest by means of a single cartilage uniting their free edges. From the other members of the group, the typical frogs are distinguished as a family by the presence of teeth in the upper jaw, and by the transverse processes of the sacral vertebra being either cylindrical, or but very slightly dilated at their extremities. These characteristics are sufficient to distinguish the typical frogs from the other families of the suborder; but it may be added that the vertebræ are cupped in front and hollowed behind; while there are no ribs; and the terminal style of the backbone is articulated to the sacrum by two condyles. The terminal joints of the toes may be either simple or pointed, T-shaped, Y-shaped, or even claw-like; the species in which these joints are thus expanded having the soft parts similarly expanded and flattened. For a long time it was considered that the shape of the tips of the toes was connected with the mode of life of their owners; and although this is so to a great extent, it is now ascertained that several of the species

in which the toes are somewhat expanded are as aquatic as those in which they are pointed, and species presenting both modifications are included within one and the same genus. The typical frogs are divided into twenty genera, only two of which are noticed in this work.

Water Frogs Under the general title of water frogs may be conveniently included all the members (some hundred and forty in number) of the genus *Rana*, to which belongs the common English frog. The distinctive characteristics of these frogs are to be found in the horizontal pupil of the eye; the more or less deeply notched and free tongue; the presence of teeth on the vomerine bones of the palate; the absence of webs in the toes of the fore-feet, and their presence in those of the hind-limb; and the separation of the outer metatarsal bones of the hind-foot by a web, the extremities of the fingers being simple or expanded.

With the exception of the southern part of South America (where the whole family is unrepresented), Papua, and New Zealand, these frogs have a world-wide distribution. Although the greater majority of the species are probably aquatic during the breeding season, at other times great diversity of habit is displayed by the different representatives of the genus, some being aquatic, others terrestrial, and others, again, burrowing, or even more or less arboreal. The existence of burrowing habits is indicated by the great development of a tubercle on the inner side of the metatarsus, which in one Indian species (*Rana breviceps*) has a sharp edge, and is used in a shovel-like manner to excavate the burrow. Such burrowing species are further characterized by the shortness of the hind-limbs, and thus assume a more or less toad-like appearance. Large discs at the ends of the toes usually, on the other hand, are indicative of arboreal habits; although, as already said, smaller discs are met with in certain purely aquatic species.

European Frogs Selecting some of the European representatives of the genus for special mention, we may first notice the edible frog (*R. esculenta*) characterized by the pointed tips of the toes, the smooth under surface of the body, the presence of a broad glandular fold along the sides, and the marbling of the thighs. Exceedingly variable in coloration, this frog generally has the upper parts olive or bronzy brown, more or less spotted or marbled with dark brown or black; there are generally three light stripes along the back, while the sides of the head and ground color of the flanks are sometimes green; the marbling on the thighs occupying their hinder surfaces, and being black in color. The males are specially characterized by the presence of a globular sac, connected with the production of the croaking, on each side of the head, opening by a slit behind the angle of the mouth. Inhabiting Europe, Asia as far west as Japan, and Northwestern Africa, the edible frog is common in England, the dark race occurring in the fens of Cambridgeshire, and the green variety in Norfolk. The use of the flesh as food probably led to the introduction of this species into Cambridgeshire by the monks; while the Norfolk colony was imported between 1837 and 1842. From this species the common English frog (*R. temporaria*) is readily distinguished by the incomplete webbing of the hind-feet, and the presence of a dark temporal spot extending from the eye to the shoulder, as well as by the absence of external vocal sacs in the males. Moreover, if the skulls of these two species be compared, it will be found that while

in the edible frog the teeth on the vomers do not extend behind the line of the apertures of the posterior nostrils, they do so to a small extent in the present species. In color the upper parts of the common frog are grayish or yellowish brown, more or less spotted with dark brown or black; the temporal spot being always dark, and a light line running from below the eye to its extremity; while the sides of the body are profusely spotted, the limbs transversely barred, and a larger or smaller number of spots are present on the under parts. This species is spread over Europe and Northern and temperate Asia. Closely allied is the moor frog (*R. arvalis*), of Eastern Europe and Western Asia, represented in the illustration on p. 2629, which



AGILE FROGS.
(Natural size.)

may be distinguished by the tubercle on the inner metatarsal being compressed instead of blunt, and by the pointed, in place of obtuse, muzzle. The coloration is very similar to that of the common species, but there is sometimes (as in the right-hand figure of the illustration) a light stripe bordered by two black ones down the middle of the back, while the under parts are uniform. A third European species is the agile frog (*R. agilis*), which belongs to a group distinguished by the greater length of the hind-limbs; the whole form being slender, and the muzzle pointed. Its general color is grayish brown, with dark spots; the temporal spot being dark and distinct, with a light line running from its extremity to the snout, while the

hind-limbs are regularly barred, and the under parts unspotted. Two other European species, the one (*R. iberica*) from Spain and Portugal, and the other (*R. latastei*) from the neighborhood of Milan, differ by the spotted lower surface of the body. Even the tadpoles of the whole of these more or less nearly-allied species present differences by which they can be distinguished from one another.

The common frog, whose habits may be taken as typical of the allied members of the genus, is found in most parts of Europe, where there is a sufficiency of moisture and shelter for its existence; the presence of water being essential during the breeding season. All are probably familiar with the manner in which a frog swallows air; but it is perhaps less generally known that if the mouth of one of these creatures be kept forcibly open, death must inevitably ensue, owing to the impossibility of breathing while in this state. The croaking of the frog is principally uttered during the breeding season; and when large numbers of these Amphibians are collected in a pond together, the volume of sound produced is considerable, and can be heard from long distances, although it is nothing compared to that of the bullfrog and many tropical species. Frogs subsist entirely on slugs, snails, insects, etc., swallowing large beetles whole, and devouring several at a meal. The frog captures its prey by suddenly throwing forward the tip of its tongue, which is invested with a viscid secretion, upon the insect or slug, and then as quickly withdrawing it to its normal inverted position. So rapid is the whole movement, that it requires a sharp eye to detect it; the insect seeming to disappear as if by magic. "Frogs retire," writes Bell, "on the approach of winter to their hibernating retreats, where they pass the dreary season in a state of absolute torpidity. This is generally in the mud at the bottom of the water, where they are not only preserved, though at low degree, but also secured from external injury. Here they congregate in multitudes, embracing each other so closely as to appear almost as one continuous mass. On the return of spring they separate from each other, emerge from their places of retirement, and recommence their active life by exercising the important function of reproducing their species." During the breeding season a warty protuberance is developed on the thumb of the male to assist in holding the female; and in some foreign species the whole fore-arm becomes enlarged at this time. The spawn is deposited at the bottom of the water, but soon rises to the surface in the well-known glairy masses; and in due season the tadpoles make their appearance. During the tadpole stage frogs are devoured in large numbers by newts and the smaller fishes; while in the adult condition numbers fall prey to the weasel and polecat, the heron and other wading birds, and the common snake, whose food is almost entirely composed of them. Although the common frog is to a large extent aquatic, it is much less so than the edible species, which inhabits indiscriminately running or still waters, the borders of rivers, rivulets, or streams, lakes or ponds, salt or fresh marshes, or even ditches and pools of water. Owing to the presence of the external sacs, the croaking of the male is louder than in the common frog. Both species, like all the more typical representatives of the genus, progress on land by means of leaps; while in water they swim with the hind-limbs alone.

Compared to the bullfrog (*R. catesbyana*) of Eastern North America, represented in the figure on p. 2624, the European frogs are mere dwarfs; but the largest

Bullfrogs species of all is Guppy's frog (*R. guppyi*), from the Solomon islands, in which the length of the head and body is upward of nine inches. The bullfrog is one of those species in which the tips of the toes are pointed, and it is especially characterized by the web extending to the tip of the fourth toe of the hind-foot, the large size of the aperture of the ear, and the relative length of the hind-leg; the two latter characteristics distinguishing it from Montezuma's frog (*R. montezumæ*) of Mexico. The body has no lateral glandular fold; and the vocal sacs of the male are internal. In color the bullfrog is brown or olive above, with darker marblings; the under parts being either uniformly colored, or marbled with brown. In length it measures from seven to seven and one-half inches, exclusive of the legs. More abundant in the southern than in the northern portion of its habitat, the bull-



JAVAN FLYING FROG.
(Two-thirds natural size.)

frog is generally met with in rivers and streams well shaded with trees or bushes, where it may be seen in numbers basking in the midday sun. Its croaking is said to be louder than that of any other species, and can be heard for a distance of several miles. In the Southern States of America, although most intense during the spring and summer, the croaking is continued throughout the year; but in the north it is confined to the spring and summer, being especially loud during the breeding season. It is a remarkable fact that in Canada, at least, the bullfrog passes the first winter in the larval condition, and takes two years to attain its full growth.

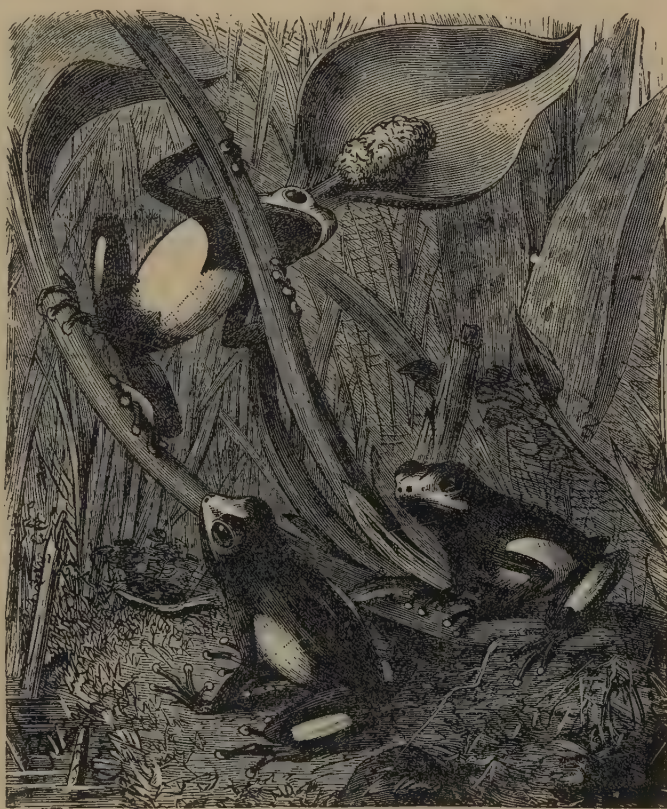
It may be mentioned that the small Indian frogs forming the genus *Oxyglossus* differ from the members of the preceding genus by the absence of any notch in the tongue, and the want of vomerine teeth. They are specially interesting on account of being represented by fossil species in the Eocene

rocks of Bombay. Fossil frogs belonging to the typical genus *Rana* occur in the lower Miocene rocks of Europe.

Flying Frogs "One of the most curious and interesting reptiles which I met with in Borneo," writes Mr. Wallace, "was a large tree frog, which was brought me by one of the Chinese workmen. He assured me that he had seen it come down, in a slanting direction, from a high tree, as if it flew. On examining it, I found the toes very long, and fully webbed to their very extremity, so that when expanded they offered a surface much larger than that of the body. The fore-legs were also bordered by a membrane, and the body was capable of considerable inflation. The back and limbs were of a very deep shining green color, the under surface and inner toes yellow, while the webs were black, rayed with yellow. The body was about four inches long, while the webs of each hind-foot, when fully expanded, covered a surface of four square inches, and the webs of all the feet together about twelve square inches. As the extremities of the toes have dilated discs for adhesion, showing the creature to be a tree frog, it is difficult to imagine that this immense membrane of the toes can be for the purpose of swimming only, and the account of the Chinaman, that it flew down from the tree, becomes more credible." The species referred to is the Bornean flying frog (*Rhacophorus pardalis*), a member of a large genus, of which another representative (*R. reinwardti*) is shown in the illustration on p. 2634. Of the forty-two species of the genus, thirty occur in South and East Asia, and the remaining twelve in Madagascar.

While allied in most re-

spects to the water frogs, they all differ by the presence of a small additional bone between the terminal and penultimate joints of the toes, and likewise by the penultimate joints being distinctly marked externally as a kind of ridge; while



VARIABLE TREE FROGS.
(Natural size.)

they are further mostly characterized by the webbing of the toes of the fore-feet, although the degree to which this is carried, is variable. The tips of the toes are always expanded into round discs, and very generally their terminal joints are forked. The males are provided with one or two internal vocal sacs. In habits these frogs are strictly arboreal; their bright green coloration harmonizing with the leaves among which they dwell. The larvæ are remarkable for the possession of an adhesive disc behind the mouth on the under surface; while the muzzle is prolonged into a proboscis, and the single breathing pore is situated on the right side of the body, nearer to the tail than to the muzzle. Writing of the habits of one of the Cingalese members of the genus (formerly separated as *Polypedates*), in which the front toes are only half webbed, Emerson Tennent observes that it "possesses in a high degree, the faculty of changing its hues; one as green as a leaf to-day will be found gray and spotted like the back to-morrow. One of these beautiful little creatures, which had seated itself on the gilt pillar of a lamp on my dinner table, became in a few minutes scarcely distinguishable in color from the ormolu ornament to which it clung."

THE SOLID-CHESTED TREE FROGS

Family *DENDROBATIDÆ*

As we have already seen to be the case with the snakes, two totally distinct families of frogs have taken to an arboreal life, and have thus become so like one another that we have to depend on anatomical differences for their distinction. In the present family, while the structure of the bones of the chest is of the same solid structure as obtains in the typical frogs, and the extremities of the transverse processes of the sacral vertebra are not expanded, an important difference presents itself in the absence of teeth in the upper jaw and on the palate. The toes of both feet are quite free from webs, and have their tips expanded into rounded discs. These frogs are represented by two genera, one of which (*Mantella*) is confined to Madagascar, and is distinguished by the tip of the tongue being notched; while in *Dendrobates* of tropical America the tongue is entire. The American genus is represented by seven species, among which the variable tree frog (*Dendrobates tinctorius*) is selected for illustration. This pretty little frog, which measures barely an inch and one-half in length, is widely distributed in tropical America, and is remarkable for its variability in color, some examples being uniformly black, others gray above and black on the sides and beneath, and others gray with large black blotches. This, however, is by no means the limit of variation, since some examples are black above, with two or three longitudinal white or pink stripes, the under parts being gray with black spots; while in other cases, the ground color is black, with white spots and streaks above, and spots or marblings of the same beneath. From the small size of the discs on its feet, which do not admit of its clinging to upright stems, this frog seems to be less arboreal than some of its allies; and it is generally

found among fallen leaves on the ground in forests. Like its kindred, it displays remarkable care and attention to its young. The secretion from its skin is employed by the Indians as an arrow poison.

THE NARROW-MOUTHED FROGS

Family *ENGYSTOMATIDÆ*

An important family of the suborder is that of the narrow-mouthed frogs, represented by more than a score of genera, distributed over Africa, Madagascar, India and the adjacent countries, Southern China, Papua, and America. While agreeing with the members of the preceding family in the absence of teeth in the upper jaw,



EAST-AFRICAN SHORT-HEADED FROGS.
(Natural size.)

these frogs are distinguished by the broad expansion of the extremities of the transverse processes of the sacral vertebra. The vertebrae are similar in conformation to those of the typical frogs, and there is the same absence of ribs. There is, however, considerable variation in regard to the bones of the chest, several of the genera lacking the transverse bars commonly known as precoracoids; and the terminal joints of the toes may be either simple or T-shaped. Although there are no arbo-

real forms, the family comprises terrestrial, aquatic, and burrowing representatives; the last having either the front- or hind-limbs specially strengthened and furnished with horny sheaths. In some of the genera, and especially the one of which a representative is here figured, the mouth is extremely narrow; and although it is convenient to take this characteristic as the basis of the name of the family, it must not be considered that it is applicable to all its members. These narrow-mouthed forms feed exclusively or mainly on ants and termites, and thus exhibit a modification of structure approximating to that characteristic of ant-eating mammals. More than half the members of the family are nocturnal, and may be recognized by the vertical pupil of the eye.

**Short-Headed
Frogs**

The exceeding plumpness of the body serves not only to distinguish the short-headed frogs (*Breviceps*) from all their allies, but also makes them some of the most peculiar of their class. Indeed, when the body is puffed out to its fullest extent, they more resemble India-rubber balls than frogs. The genus belongs to a group in which the so-called precoracoid bones are present and the metacoracoids much dilated; and they are specially distinguished by the horizontal portion of the pupil and the absence of teeth on the palate. Three species are known, all of which are African, the one here figured (*B. mossambicus*) inhabiting the eastern districts. Generally having a perfectly smooth skin, this frog is of a brown or blackish hue on the upper parts, with a dark oblique streak below the eye. The narrow mouth and long tongue of this curious frog indicate that its food consists of white ants.

Darwin's Frog

A frog (*Rhinoderma darwini*) belonging to the present family, and inhabiting Chili, alone represents a genus remarkable for the throat sac of the males being enlarged and modified so as to form an extensive chamber on the under surface of the body in which the eggs and tadpoles undergo their development. This chamber is entered by two apertures situated on the floor of the mouth on each side of the tongue; and when the eggs, generally from eleven to fifteen in number, are laid by the female, they are taken and swallowed by her consort, who passes them into his pouch. When the tadpoles are sufficiently developed, they enter the world by escaping through the parental mouth. It appears that at no stage of their existence do the tadpoles possess external gills.

THE SHARP-NOSED FROG

Family CERATOBATRACHIDÆ

Omitting detailed mention of the small and unimportant family of the *Discophidæ*, characterized by the presence of teeth in the upper jaw, and the expansion of the extremities of the transverse processes of the sacral vertebra, our last representative of the first suborder is the sharp-nosed frog (*Ceratobatrachus guentheri*), of the Solomon islands, which constitutes a family by itself. The essential characteristics of the family are the presence of teeth in both the upper and lower jaws (a feature found elsewhere only in two families of the next suborder), coupled with the

absence of expansion of the extremities of the sacral vertebræ. This frog has a very large triangular head, ornamented with prominent ridges, and terminating in front in a pointed flap of skin; similar flaps occupying the eyelids, and the mouth having an enormous capacity. In the eye the pupil is horizontal; and teeth are present on



SOLOMON ISLAND SHARP-NOSED FROG.
(Natural size.)

the vomers. The hind-limbs are rather short; and all the toes have simple terminations, and are devoid of webs. In color this curious frog is very variable. Although very little is known as to its habits, it appears to be abundant in the Solomon islands; and it is remarkable for laying very large eggs, from which the young emerge nearly fully developed.

THE SOUTHERN FROGS

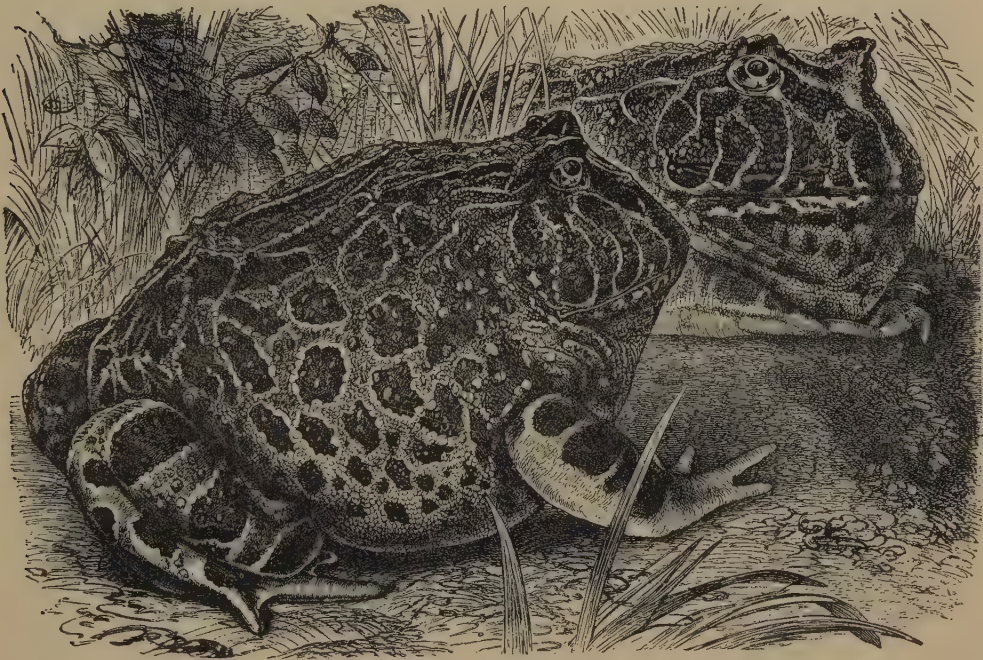
Family *LEPTODACTYLIDÆ*

In the greater part of South America and almost the whole of Australia the typical frogs are replaced by a family which, for want of a better name, we may call the southern frogs. These, together with seven other families, differ essentially from the forms hitherto considered, in regard to the conformation of the bones of the chest, and thus collectively constitute a second suborder, known as the Arcifera. It will be remembered that in the preceding suborder the two metacoracoid bones are connected together by a single cartilage joining their free edges; in the present group each metacoracoid terminates in a large cartilage, in such a manner that one cartilage overlaps its fellow of the opposite side. The southern frogs resemble the typical frogs in having the upper jaw alone toothed, and in the transverse processes of the sacral vertebra being cylindrical or but slightly expanded, while they also agree in the characteristics of the vertebræ and the absence of ribs. It is thus evident that the two groups form parallel or representative series; but it must always be remembered that it is only an assumption that the conformation of the bones of the chest is the characteristic of primary import; and that it is quite possible that there may have been parallelism in this case also, in which event the present family would have to be placed next the true frogs. The present family is confined to the countries mentioned above, and is represented by twenty-five genera and some one hundred and eighty species. While most of the American forms have the pupil of the eye horizontal, this condition occurs but rarely in those from Australia.

Horned Frogs Among the best-known representatives of the family are the horned frogs or horned toads (*Ceratophrys*) remarkable alike for their large size and brilliant coloration, as well as for the enormous dimensions of their mouths and their fierce and carnivorous habits. Represented by about half a score of species from tropical and South America, they belong to a group characterized by the more or less marked union of the outer metatarsals, the absence of a bony style to the breastbone, and the webbing of the hind-toes; while, as a genus, they are distinguished by the horizontal position of the pupil and the notching of the tongue. The webbing of the toes varies in extent in the different species, but there is never any expansion of these extremities. The outer metatarsals are completely united, and the skull is remarkable for the extent to which ossification is carried out. In some species, such as the Brazilian horned frog (*C. boiei*), the upper eyelid is produced into a horn-like appendage; but in others, like the Argentine horned frog (*C. ornata*), this is little developed and scarcely noticeable.

The largest representative of the genus is the above-mentioned Brazilian horned frog, which attains as much as eight inches in length, and is one of the most handsomely ornamented of the genus. The smaller Argentine species represented in our illustration differs from it by the upper eyelid being only slightly pointed and triangular, as well as by the presence of a bony shield on the back.

The skin is covered with tubercles above and granules below; the general color of the upper parts being yellowish or greenish, with large olive spots surrounded by light colored or golden margins, while there are sometimes wine-red lines between the spots. These frogs or escuerzos, as they are locally called, are abundant in many parts of Argentina, and in damp weather may be met with crawling about among the grass in numbers, after the manner of toads. They are exceedingly bold and ferocious, flying fiercely at any one who attacks them, and maintaining their hold with the tenacity of a bulldog, at the same time uttering a kind of barking cry. On other occasions they give vent to a peculiarly-deep bell-like note. When in repose, escuerzos are in the habit of burying themselves in the soil with only the



ARGENTINE HORNED FROGS OR ESCUERZOS.
(Natural size.)

top of the back exposed, in which state they are almost invisible. In this position they lie in wait for their prey, which includes other frogs, birds, and small mammals; and at times they capture and attempt to swallow objects too large for their capacity.

Another American genus, containing a very large number of species, is that of the leaf frogs (*Hylodes*) which deserve mention on account of the peculiar reproduction of one of its representatives, the so-called Antillian frog (*H. martinicensis*). These frogs differ from the group to which the last genus belongs by the absence of a bony style to the breastbone, and the unwebbed hind-toes; while they are further characterized by the expansion of the tips

of the toes into smooth discs, the horizontal pupil of the eye, and the presence of teeth on the vomer. The Antillian frog or, as it is locally termed, coqui is an inhabitant of several of the West Indian Islands, and may be recognized by its warty under surface; the general color of the upper parts being gray or brownish, with indistinct darker marking on the head and back, and crossbars on the hind-legs; while there is a large dark mark on the temporal region, and another near the muzzle. The remarkable fact connected with the reproduction of this species is that such transformations as are undergone by the larvæ take place within the large eggs; the creatures emerging from which undergo no further alteration, with the exception of the absorption of the remnant of the tail. In this respect the coqui resembles the sharp-nosed frog of the Solomon islands.

As the typical representatives of the family, brief mention must be made of the piping frogs (*Leptodactylus*) of Central and South America, which differ from the preceding genera in having a dagger-like bony style to the breastbone; and having the pupil of the eye horizontal, and the teeth on the vomers placed behind the apertures of the inner nostrils. Externally these frogs closely resemble the ordinary European water frogs, with the exception that the hind-toes are not webbed. In the males the humerus is expanded into a large flange-like plate; and in the breeding season the whole fore-limb is much swollen for the purpose of firmly holding the female. These frogs derive their names from their loud pipe-like croaking, which varies in tone and intensity according to the species. Some are noteworthy from their habit of digging a hole in the ground near water, and lining it with a layer of scum, upon which the eggs are deposited, and left to hatch. The nests seem, however, always to be so placed that at a certain season they will be flooded by the rise of the neighboring water. When first hatched the tadpole is not unlike that of the frog, although with a relatively-smaller tail; and when the nest becomes flooded the mode of life of its occupants is similar to that of the ordinary frog larvæ.

THE TOADS

Family *BUFONIDÆ*

Passing over the unimportant family of the *Dendrophryniscidæ*, including only two small South-American genera, our next representatives of the suborder are the true toads, which constitute a family distinguished by the absence of teeth in both jaws, and the expansion of the extremities of the transverse processes of the sacral vertebra. The vertebræ resemble those of the typical frogs, and there is the same absence of ribs as in the latter. The terminal joints of the toes are either blunt, or T-shaped; and in only two out of the eight genera is the pupil of the eye vertical. Two of the genera approximate in character to the preceding family. The toads have an almost cosmopolitan distribution, and while the more typical forms are characterized by their terrestrial habits, rough skin, and creeping gait, so unlike that of the frogs, others are burrowing, and others, again (*Nectes*), thoroughly

aquatic. Moreover, the disc-footed toads (*Nectophryne*) of Western Africa and the Oriental region, in which the toes terminate in disc-like pads, appear to be arboreal; while the one Mexican representative of another genus (*Rhinophrynus*) is distinguished by its ant-eating habits.

True Toads The common toad (*Bufo vulgaris*) is the typical representative of a large genus, with some eighty-five species, ranging over the whole world, with the exception of Madagascar, Australia, New Guinea, and the islands of the Pacific. As a genus, the true toads are distinguished by the entire tongue, the horizontal pupil of the eye, the freedom of the toes of the fore-foot, and the partial webbing of those of the hind-limbs, as well as by the breastbone being either cartilaginous or with only a partially ossified style. The degree of webbing of the hind-toes varies; and while the tips of the toes are generally simple, they are sometimes expanded into small discs. The head may or may not have bony ridges. The common toad belongs to a group characterized by the absence of these ridges, and by the hind-toes being at least half webbed; while it is specially distinguished by the absence of a fold on the ankle, and by the tubercles beneath the joints of the hind-toes being mostly double. On the upper parts are more or less prominent warts, which, although frequently spiny, are not distinctly porous; and the glands behind the eyes are remarkably prominent, and of an elongated elliptical form. In color, the upper parts are brownish, with darker spots or marblings; while the lower surface is whitish, more or less thickly spotted with black. A black line runs on the outer side of the gland behind the eye; this line, in specimens from China and Japan, extending along the upper side of the flanks. The distributional area of the species includes Europe, Asia (exclusive of India and adjacent regions), and North-western Africa. Few animals have suffered more from popular superstition than the common toad, which, although practically harmless, has been almost universally shunned and detested. It is, however, true that the secretion from its skin is acrid and irritating, as may be seen by the foaming lips of dogs which attempt to meddle with these amphibians. Sluggish and terrestrial in its habits, the toad needs not the long and fully-webbed hind-limbs of its active cousin, the frog; its usual pace being a kind of crawl, although, when disturbed, it can execute an imperfect leap. When alarmed, or threatened with danger, a toad immediately stops and puffs out its body to its utmost capacity, at the same time causing the acrid secretion to exude from the pores of its skin, and likewise discharging a pure limpid fluid from a special reservoir. Of its general habits, Bell writes that the toad "becomes torpid during the winter, and chooses for its retreat some retired and sheltered hole, a hollow tree, or a space among large stones, or some such place, and there remains until the return of spring calls it again into a state of life and activity. Its food consists of insects and worms of almost every kind. It refuses food which is not living, and, indeed, will only take it at the moment when it is in motion. When about to feed the toad remains motionless with its eyes turned directly upon the object, and the head a little inclined toward it, and in this attitude it remains until the insect moves; when, by a stroke like lightning, the tongue is thrown forward upon the victim, which is instantly drawn into the mouth. . . . When the prey is taken, it is slightly pressed by the margins of the jaws; but as this seldom kills it, unless

it be a soft tender larva, it is generally swallowed alive. Toads will also take earth-worms of considerable size; and it is a curious sight to watch the manner in which the powerful and writhing worm is secured. If the toad happen to take it by the middle, the extremities of the worm are twined with great force and activity around the muzzle of its captor in every direction, in its attempts to escape; but the toad pushes one portion after another into its mouth, by means of the fore-feet, until it all disappears, when it is swallowed whole." The eggs of the toad differ from those of the frog in that, instead of forming an irregular mass with their inclosing jelly, they are arranged in a regular, double, and alternating series in the form of a string, which may be a yard or more in length. These strings are generally deposited in the water about a fortnight later than the spawn of the frog; and it is not till autumn that the young toads complete their metamorphosis, and forsake the water. From that of the frog, the tadpole of the toad is distinguished by its smaller size and blacker color.



MEXICAN SHARP-NOSED TOAD.
(Natural size.)

Green Toad

The green toad (*Bufo viridis*) of Europe, Asia, and Northern Africa, is a far handsomer species, distinguished by the presence of a fold on the ankle, and likewise by the simple structure of the tubercles on the lower surface of the toes of the hind-foot. There is likewise a vocal sac beneath the throat of the male, which is wanting in the common toad. The upper parts carry a number of irregular, flattened, and porous warts; and the glands behind the eyes, although sometimes enormously developed, are generally of moderate size and more or less kidney shaped. The color is olive or greenish above, generally spotted or marbled with a darker shade, although occasionally nearly uniform; while the under parts are either uniformly whitish, or whitish with dark spots.

Natterjack Toad

A third European species, which, unlike the last, is locally represented in England, is the natterjack toad (*B. calamita*) easily recognized by the yellow or whitish line running down the middle of the back. From both the preceding it is distinguished by the much smaller extent of

the webbing of the hind-toes; while there is a fold on the ankle, and the tubercles on the joints of the lower surface of the hind-toes are to a large extent double. The hind-limb is unusually short; the flattened warts on the back are distinctly porous; the glands behind the eyes are small, depressed, and either oval or triangular; and there is an additional gland on the leg. The general color of the upper parts is light olive, with darker marblings or spots, the above-mentioned light line being generally present; while the light under parts are more or less spotted with black. In its movements the natterjack is less sluggish than the common toad, its pace being often quickened to a kind of run, during which the body is raised considerably above the ground. It is likewise less intolerant of drought, being frequently found in hot, sunny situations, and only resorting to the neighborhood of water during the breeding season.

Sharp-Nosed Toad The Mexican sharp-nosed toad (*Rhinophrynus dorsalis*), already referred to as subsisting on white ants, is the only other member of the family that we have space to mention, and is generically distinguished by the long and narrow tongue being free in front, by the vertical pupil of the eye, and by the rudimentary breastbone. The front-toes are free, and those of the hind-limb webbed, with simple tips; while the general form of the body is extremely stout; the head small, with a long, truncated muzzle and narrow mouth; the eyes being small, and the limbs remarkably short. In color this toad is olive brown or bluish gray above, frequently with yellowish spots on the flanks and middle of the back, those on the back sometimes uniting to form a line.

THE OVERLAPPING-CHESTED TREE FROGS

Family *HYLIDÆ*

The numerous, mostly arboreal, frogs thus designated form a family comprising some ten genera, very abundant in Australia and America, and more sparingly represented in Europe, Asia north of the Himalayas (one species ranging into Northeastern India and Burma), and Northern Africa. While resembling the toads in the expansion of the processes of the sacral vertebra, they differ by the presence of teeth in the upper jaw, and they are peculiar in the claw-like form of the terminal joints of the toes. The vertebræ are cupped in front, and spherical behind, and there are no ribs.

Grasshopper Frog The grasshopper frog (*Acris gryllus*) of North America is the sole representative of a genus characterized by the horizontal pupil of the eye, the webbing of hind-toes, of which the tips are but little expanded, and the slight expansion of the processes of the sacral vertebra. In form this little frog is slender, with a narrow head and rather sharp muzzle; while the skin of the upper parts is either smooth or slightly tuberculated, and that of the under parts granulated. The mottled and striped coloration is very variable, the ground tint ranging from reddish brown to green; but there is generally a large, triangular, dark brown spot between the eyes, and sometimes a light stripe down the back. Locally



GRASSHOPPER FROGS.
(Natural size.)

very abundant in Eastern and Central North America, the grasshopper frog derives its name from its piercing, strident cry, which resembles the noise of its insect namesake. It frequents stagnant waters, and is fond of resting on the leaves of aquatic plants. Unlike most of its allies, it lurks among plants, and seldom, if ever, ascends bushes or trees.

Closely allied to the last are the numerous species of typical tree frogs (*Hyla*) which are by far the most beautiful representatives of the entire order, and are best known by the

common European species. In this genus the pupil of the eye is horizontal, the toes of both limbs dilated into discs, and those of the hind-foot more or less extensively webbed, the tongue either adherent or more or less free behind, and the expansion of the transverse processes of the sacral vertebra more or less strongly marked. As in the last genus, there are teeth on the vomers. Represented by about one hundred and fifty species, this genus has a distribution coextensive with that of the family; the sole Indian member of the latter being included. The under surface of their bodies is very different to that of the terrestrial species; for the skin, instead of being smooth, is covered with granular glands, pierced by numerous pores, through which the dew or rain, spread on the surface of the leaves, is rapidly absorbed into the system, and reserved to supply the moisture necessary for cutaneous respiration. Except during the breeding season, when the greater number of them seek the water, or when they retire before the cold of winter or drought of summer under mud, beneath stones, the bark of trees, or in other safe spots, these frogs spend their lives among the leaves of trees, where they find alike their dwelling places and their hunting grounds. As in the case of the flying frogs, their color harmonizes exactly with their natural surroundings, and changes even more rapidly than that of the chamæleons. So exactly indeed do they resemble the foliage among which they hide, that it is often difficult to tell frogs from leaves; and it has been noticed that where there is the greatest variety and brilliancy of color among the forest trees, the tree frogs attain their most brilliant and varied tints.

The European tree frog (*H. arborea*), which is one of three species inhabiting the Old World proper, has a wide geographical distribution, inhabiting the greater part of Europe, Asia north of the Himalayas as far east as Japan, and North Africa. With the exception of the higher mountain ranges and the extreme north, as well as Norway and Britain, it is spread over the whole of Europe, although varying

locally to a considerable degree in coloration and habits. The males are furnished with a large external vocal sac on the throat, and the skin is smooth above and granulated beneath. The general coloration may be described as greenish above, and uniform whitish beneath, but there are many variations in regard to the markings on the upper parts; the typical form having a grayish or black light-edged streak extending from the nostrils through the eye and ear along each side of the body, and sending a branch upward and forward on the loin, while a whitish line descends from the upper lip to the shoulder, and then runs upward to the eye, thus inclosing an elongated green area. In habits this frog is most active; and while in swimming it is nearly equal to the common frog, in leaping it is its superior, in addition to which it is a most expert climber. When croaking, the sac on the throat of the males becomes so inflated as to make this appendage nearly as large as the body. Like toads, tree frogs do not appear to touch the insects on which they prey until these begin to move. Flies, spiders, beetles, butterflies, and smooth caterpillars appear to form their favorite food; although they have been known to attack and kill humble bees. The European species is of very small size, but some of the American and Australian species attain comparatively large dimensions, one of the largest members of the genus being *H. faber*, of Brazil, which measures as much as three and one-half inches in length.

Nesting Habits An interesting account of the breeding habits of the frog last mentioned, which in Brazil is known as the *ferreiro*, or smith, is given

by Dr. Goeldi, whose observations were made in the Organ mountains, adjoining the bay of Rio de Janeiro. This frog makes regular pools of a circular form in the shallow borders of ponds and swamps, such pools being surrounded by a narrow mud wall. In 1894 one pond contained nine of these pools, which served as nests for the tadpoles. "On the night of the eighteenth of February," writes the describer, "between nine and eleven o'clock, we approached the pond,



EUROPEAN TREE FROGS.
(Natural size.)

occupied, as we could hear from a distance, by at least a dozen of the large tree frogs. The moon was shining brightly, and much favored our undertaking, but even under these circumstances we had to accustom our sight to discern the details in the marginal vegetation, and the portion somewhat hidden in the

shadow. By and by we discovered the ferreiros, some at work, others drumming together on the walls of some pool, or in the middle of the pond, sitting upon some floating object, such as water plants. The vocalists, of which we could distinguish the moderately-inflated gular sacs, were all males." After stating that he was posted on a side of the pond where five nests were already situated, Dr. Goeldi observes that he and his companion were fortunate enough to see the rising of a new nest. In a certain spot he writes that "we first saw some slight movement in the water, produced by something stirring below the surface. We then soon saw a mass of mud rising to the surface, carried by a tree frog, of which no more than the two hands emerged. Diving again, after a moment's time, the frog brought up a second mass of mud, near the first. This was repeated many times, the result being the gradual erection of a circular wall. From time to time the head and front part of the body of the builder appeared suddenly with a load of mud at some point; but what astonished us in the highest degree was the manner in which the frog used its hands for smoothing the mud wall, as would a mason with his trowel. And by examining the hands of this hyla, it will readily be understood how they are most serviceable trowels, their terminal joints bearing large expansions. This careful process of smoothing could be better observed as the wall gradually heightened, until it reached about four inches, when the frog was compelled to come out of the water. The parapet of the wall receives the most careful smoothening, the outside being neglected, and the leveling of the bottom attained by the action of the lower surface of the creature's body, aided by the hands. The aspect of the pool may be compared to the crater of a volcano, or a vessel of a foot in diameter filled with water. Although the female undertakes the entire task of building, she is incommoded the whole time by the male sitting on her back. Should he be frightened from his post, he will soon emerge from the water at a distance of a few feet, when, if signs of danger be wanting, he will climb the walls of the nest and regain his original seat."

Another Brazilian tree frog of the same genus (*H. goeldii*) breeds in the water contained in the central cup of certain trees belonging to the *Bromeliaceæ*. Dr. Goeldi states that the first specimen found was a female, carrying on her back a large globular mass of whitish eggs. When put in a vivarium, "for a few days the egg mass remained attached to the mother's back. But suddenly it fell away, and simultaneously I saw in the glass some small, nearly black colored frogs, all provided with the anterior and posterior legs, together with a larval tail of medium or rather small size."

Yet another tree frog from Brazil (*H. nebulosa*) has acquired the remarkable habit of depositing its eggs in the sheaths of old and decaying leaves of bananas. The writer from whom we have been quoting states that this frog "glues its lumps of eggs on the edges and on the inside of banana leaves, where, even during the hot hours of the day, sufficient coolness and moisture are preserved. These lumps are inclosed in a frothy, whitish substance, comparable to the scum formed by certain *Cicadidæ*. Sometimes the tailed larvæ are seen struggling in this frothy mass. If put into fresh water, all will die in a few hours."

Pouched Tree Frogs On account of the peculiarity of their reproduction, mention must be made of the curious pouched tree frogs (*Nototrema*), distinguished from the typical genus by the presence of a backwardly-opening pouch at the hinder end of the back in the females. These frogs are represented by some half-dozen species, mainly confined to Central and Western tropical America, although one of their number is found on the eastern side of that continent at Pernambuco. The pouch of the female is extended beneath the skin of the back and sides to form a very large chamber, in which the eggs and tadpoles undergo the whole of their transformations. The eggs, generally fifteen or sixteen in number, appear to be placed in the pouch by the male, who employs his hind-feet for the purpose; and they are remarkable for the large relative size of the yolk. The tadpoles, when first hatched, are peculiar in having a bell-shaped structure for the protection of their two pairs of external gills.

THE TOAD FROGS

Family *PELOBATIDÆ*

The fifth family of the order belonging to the section with overlapping cartilages to the metacarpoids comprises eight genera, which may be collectively termed toad frogs, since they come neither under the designation of toads or frogs. Agreeing with the tree frogs in the presence of teeth in the upper jaw, they may be distinguished by the much greater expansion of the processes of the sacral vertebra, ribs being absent, and the terminal joints of the toes simple. In all the forms the pupil of the eye is vertical; and whereas the majority of the genera agree with the preceding groups in having the articular cup at the front and the ball behind, in a few this arrangement is reversed. The family is distributed over Europe, the Oriental region, North America, and New Guinea; the various genera having a more or less restricted geographical range.

Brown Toad Frog The brown toad frog (*Pelobates fuscus*) is the typical representative of a genus containing two European species, neither of which are found in Britain. They are characterized by the rod at the end of the backbone being welded to the sacral vertebra, and by the extensive webbing of the hind-toes; the presence of a bony style to the breastbone, coupled with the want of an externally visible ear membrane, serving to distinguish them from an allied North-American genus (*Scaphiopus*). The brown toad frog is a rather large species, usually measuring from two and one-half to three inches in length, and having a smooth brown skin, marbled on the upper parts with darker markings; a spur which is present on the metatarsus being yellowish brown. The males have no vocal sac, but are furnished with a large elliptical gland on the upper surface of the fore-limb. This species is decidedly local, and in some districts is replaced by the allied *P. caltripes*, easily distinguished by the black spur on the metatarsus. Spending only a few days during the breeding season in the water, it is essentially a land animal, generally frequenting spots with a sandy soil. Here, with the aid of

its metatarsal spur, it rapidly excavates hollows in the ground, throwing out the earth backwards, and soon partially concealing itself. An aperture is, however, always left to the excavation, and should the rays of the morning sun reach its occupant, the burrow is quickly deepened. In its movements the toad frog is more active than the toads, approaching in this respect the frogs, as it takes considerable leaps, swims strongly, and burrows with rapidity. The breeding season takes place in April, during which time the males utter a loud croaking accompanied in a lower tone by the females. The eggs are laid in strings of about a couple of feet in length; and are taken from time to time by the male and carefully deposited round reeds, grass, or other plants growing near the edge of the water. In from five to six days the small black tadpoles are hatched out; and in the course of four months these have completed their development and leave the water. When an adult toad frog is suddenly seized or pinched, it utters a cry like the mewling of a kitten, at the same time emitting a pungent vapor with a strong odor of garlic, both these being apparently intended as a means of defense.

Other Genera Of the remaining genera, *Pelodytes*, as represented by the punctured toad frog (*P. punctatus*) of Western Europe, and the Papuan *Batrachopsis*, differ from the preceding in that the sacral vertebra has two condyles for articulation with the rod forming the termination of the backbone, the hind-toes being slightly webbed. In the Oriental genus *Leptobrachium*, there is but a single condyle for the articulation of the rod-like bone.

Allied Extinct Frogs In the Miocene rocks of Europe there occur remains of numerous frogs which are assigned to an extinct genus, *Palæobatrachus*, regarded as representing a family (*Palæobatrachidæ*) connecting the present one with the under-mentioned *Xenopodidæ*. In these extinct forms the upper jaw is toothed, the transverse processes of the sacral vertebra have expanded extremities; the sacral vertebra articulates with the terminal rod of the backbone by means of two condyles; the vertebræ have their articular cup in front; and there are no ribs.

THE DISC-TONGUED FROGS

Family *DISCOGLOSSIDÆ*

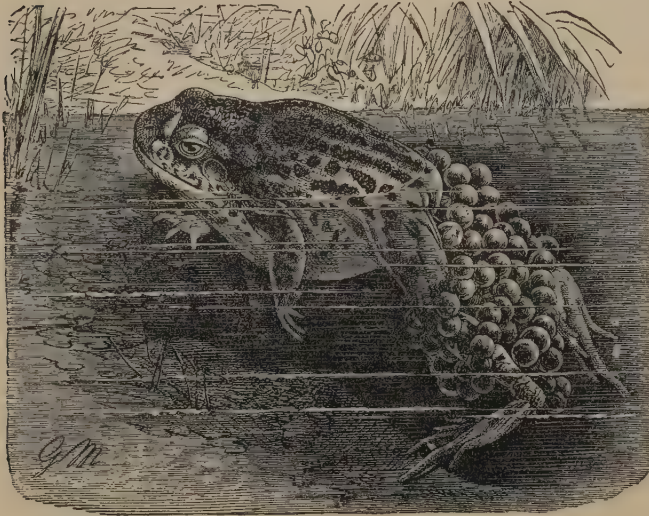
The disc-tongued frogs, as the members of this group may be called, form a small family represented by four genera and seven species, inhabiting the northern half of the Old World and New Zealand. As a family, these frogs are characterized by the presence of teeth in the upper jaw, the expansion of the processes of the sacral vertebra, the presence of short rudimentary ribs, and the circumstance that in the bodies of the vertebræ the articular cup is placed at the hinder end, and the ball in front. In both the latter respects these frogs resemble the salamanders and newts, and they may accordingly be regarded as some of the least specialized representatives of the order. Their remains occur abundantly in the middle Tertiary rocks of Europe. The family derives its name from the disc-like form of the tongue, which may be either free or adherent. From all the forms hitherto

described, the tadpoles, after shedding the external gills, differ in having the breathing pore situated in the middle of the under surface of the body, instead of on the left side.

Fire-Bellied Frog From the painted frog (*Discoglossus pictus*) of Southern Europe and Northwestern Africa, which alone represents the typical genus of the family, the fire-bellied frog (*Bombinator igneus*), represented in the figure on p. 2622, is distinguished by the absence of an external tympanic membrane to the ear; while it is further characterized by the adherent tongue, the triangular form of the pupil of the eye, and the great expansion of the extremities of the transverse processes of the sacral vertebra. This frog, which inhabits Europe and Asia, although unknown in the British Islands, has the skin very warty on the upper parts, while beneath it is nearly smooth. In color it is olive above, with or without black marblings; beneath it is orange or yellow, marbled with black. The males are devoid of a vocal sac, but during the breeding season they develop black rugosities on the inner side of the fore-arm, as well as on the inner tubercle of the metacarpus, and on the two innermost front-toes. There are two varieties of this frog (reckoned by some as distinct species) of which the one with orange colored under parts is to be found in streams or marshes in the lowlands, while the yellow-bellied form lives at considerable elevations in the mountains. They are essentially aquatic frogs, only leaving the water for a short time in the spring, when they may be seen hopping on the land on their long hind-legs. In the water they generally take up their position at some distance from the bank, sitting with their heads slightly raised above the surface, and disappearing with lightning-like speed at the slightest noise, to seek safety in the mud at the bottom. The tadpoles grow to an unusually large size, and are especially characterized by the great development of the tail fin.

Midwife Frogs The third European representative of the family is the so-called midwife frog (*Alytes obstetricans*) of which the typical form inhabits France, Switzerland, Belgium, and Western Germany, while a variety occurs in Spain and Portugal; Spain being also the home of the second member of the genus (*A. cisternasii*). From the fire-bellied frog these two species are distinguished by the distinct external tympanic membrane to the ear, the elliptical and vertical pupil of the eye, and the moderate expansion of the transverse processes of the sacral vertebra. The common species has the skin of the upper parts warty, while that of the under surface is granular; the glands near the head are small or indistinct, but there are large ones on the limbs; and the males have no vocal sac. The color of the upper parts is olive gray, with darker dots and irregular spots. Essentially an aquatic species, this frog derives its name from the circumstance that the male takes charge of the eggs during their development. The breeding season lasts for upward of six months, namely, from March to August, although the eggs are laid only from March till June. These are deposited by the female in the form of long chains, which may be upward of a yard and a half in length. These chains are taken by the male, and wound round his legs and thighs; and when thus loaded he retires to some burrow or convenient hollow near the bank, where, at least during the daytime, he remains in concealment until the tad-

poles are ready for hatching. He then enters the water, and the tadpoles soon come forth, and swim away to take care of themselves; the hatching of the tadpoles taking place from June till September. After the cares of the nursing period are



MALE OF MIDWIFE FROG WITH CHAINS OF EGGS.
(Natural size.)

over, the male loses his voice, which is not resumed till the following February, when it is continued till August. The males are more numerous than the females, and during the breeding season their loud croaking is almost continuous. From September till the beginning of March the habits of this sex are similar to those of other frogs. The lower Miocene strata of the Continent have yielded remains of an extinct frog belonging to the same genus, while in the rocks of the

upper part of the same division of the Tertiary period there occurs a gigantic frog belonging to the same family, which has been referred to an extinct genus, under the name of *Latonia*.

Other Families — The other two families — *Amphignathodontidæ* and *Hemiphractidæ* — belonging to the present suborder are not of much importance, and are represented only by a small number of genera and species from Central and South America. They are, however, of some interest, from the circumstance that both the upper and lower jaws are furnished with teeth, in which respect they agree with the sharp-nosed frog among the members of the first suborder.

THE TONGUELESS FROGS

Families *XENOPODIDÆ* and *PIPIDÆ*

The members of the order hitherto considered are furnished with a well-developed tongue, but in the order Aglossa, this organ is totally wanting. The vertebræ resemble those of the disc-tongued frogs in having their articular cups at the hinder ends, but ribs are wanting. The metacoracoids correspond in structure to those of the suborder Arcifera, although the cartilages at their edges do not overlap. The tadpoles of these remarkable frogs exhibit the peculiarity of having a pair of breathing pores, after the loss of the external gills, situated symmetrically

on each side of the body. Each family is represented by a single genus, respectively confined to tropical Africa and tropical South America.

Spur-Toed
Frog

The spur-toed frogs (*Xenopus*) of which there are three species from tropical Africa, are characterized as a family by the presence of teeth in the upper jaw; while they are further distinguished by the circular pupil of the eye, the absence of an external tympanic membrane to the ear, the free front-toes, and the webbed hind-foot, in which each of the three inner toes is fur-



SMOOTH SPUR-TOED FROG AND ITS TADPOLE.
(Natural size.)

nished with a sharp, spur-like nail. The smooth spur-toed frog (*X. laevis*), which is the species here represented, has a wide geographical distribution, ranging from Abyssinia to the Cape; and is characterized by its smooth skin, marked round the body with more or less distinctly defined tube-like lines. In color it is dark brown above, and whitish beneath, some individuals being uniform, while others are spotted with brown on the under surface. The spur-toed frogs are exclusively aquatic, pursuing even their prey beneath the surface of the water, and capturing

it with their fore-feet. The pairing season takes place in August, and the large eggs are laid singly. The tadpoles, which at birth have already lost their external gills, on the third day after leaving the eggs develop a pair of barbels hanging down from the corners of the mouth.

The second family, distinguished by the absence of teeth in both jaws, is represented solely by the Surinam water toad (*Pipa americana*), which has long enjoyed a world-wide reputation, on account of the very singular manner in which the eggs are lodged during the period of their development. Agreeing with the spur-toed frogs in its circular pupil,

Surinam
Water
Toad



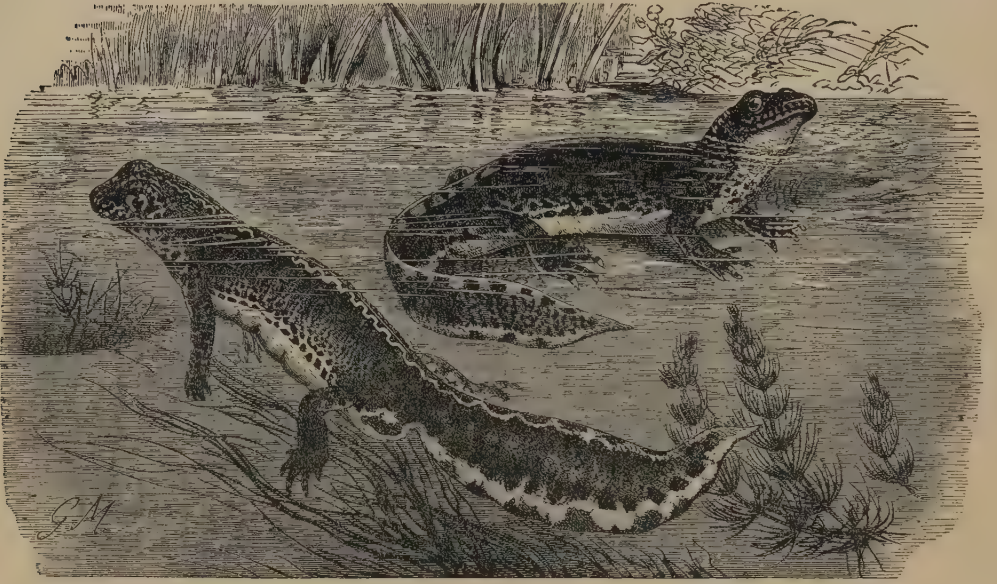
FEMALE SURINAM WATER TOAD, SHOWING YOUNG IN THEIR CELLS.
(One-half natural size.)

smooth palate, and absence of a tympanic membrane to the ear, the Surinam toad has the extremities of the free front-toes dilated into radiating appendages, while the fully-webbed hind-toes are devoid of nails. In form the head is triangular and much depressed, with the eye minute, one or two short tentacles on the lip in front of the eye, a large flap at each corner of the mouth, and sometimes a third at the tip of the muzzle. The skin, which is covered with small tubercles, is olive brown or blackish on the upper parts, while beneath it is lighter, being sometimes ornamented with white spots, and at others with a black stripe down the middle line.

The Surinam toad is an inhabitant of the damp forests of the Guianas and Brazil, and the females deposit their eggs after the usual manner in the water. At this period the skin of the back of the female becomes extremely soft and much thickened and the eggs, as soon as laid, are taken by the males and embedded one by one in this softened skin, which soon closes over, so as to inclose each in a separate cell. In these cells the eggs undergo the full course of development, the juvenile toads issuing forth from their confinement in a perfect condition, although their dimensions are, of course, small, and no gills being developed at any stage. Although there may be as many as one hundred and twenty cells in the back of a single individual, the more usual number is from sixty to seventy. The period from the deposition of the eggs to the appearance of the young toads is eighty-two days, and the young, when first bursting through the covering of their cells, generally protrude the head or one limb. Soon after the birth of her offspring the female changes the superficial layer of her skin by rubbing it off against stones or plants; the place occupied by each cell being then indicated by a small pit. Except during the breeding season, the pipa appears to be completely aquatic.

CHAPTER II

NEWTS, SALAMANDERS, AND COECILIANS — ORDERS CAUDATA AND APODA



ALPINE NEWTS.

THE newts and salamanders are readily distinguished from the frogs and toads by the retention of the tail throughout life. Hence they are collectively designated the Tailed Amphibians. Although they have generally two pairs of limbs, in a few instances the hind pair is wanting; and in all cases the bones of the limbs are of a normal type, the radius and ulna in the front pair, and the tibia and fibula in the hind ones remaining distinct from one another. In the skull the frontal bones are not united with the parietals, and the palatine bones are distinct from the jawbones or maxillæ. Generally more or less lizard-like in form, the Tailed Amphibians undergo a less marked metamorphosis than the tailless group, some even retaining gills throughout life. As regards their geographical distribution, the salamanders and newts, of which there are rather more than one hundred and twenty existing species, are mainly characteristic of the Northern Hemisphere, being represented only by a few scattered forms in the Southern Hemisphere, and quite unknown in Africa south of the Sahara and in Australasia. The northern part of the Old World is the home of the true newts, of which four species extend into Northern Africa; and it likewise contains one of the fish-like salamanders and the olm. True newts

are very abundant in the western portion of this region, but as we proceed eastward they become less numerous, and we notice an approximation to American types of the order, although only two genera are common to the Old and New Worlds. North America is especially rich in Tailed Batrachians, containing more than half the representatives of the entire suborder, and having the two-legged salamanders (*Sirenidae*) peculiar to it. Axolotls are here especially abundant, and there are also peculiar genera belonging to the families of the fish-like and gilled salamanders. The Oriental region possesses only two species, namely, a peculiar genus (*Tylotriton*) of newts in Yunnan and the Eastern Himalayas, and an axolotl in Siam. Tropical America, on the other hand, has ten species; among which may be specially noticed the newts of the genus *Spelerpes*, which are also represented by one species from Central America and the West Indies, and two others from the mountains of Colombia, Ecuador, and Northern Peru. Geologically, the group is by no means an old one, its earliest known representative (*Hylzobatrachus*) occurring in the Wealden strata of Belgium; and these animals do not appear to have become abundant until the Tertiary epoch.

Nearly all newts and salamanders appear to be inhabitants of water during at least some period of their existence; some frequenting muddy swamps, and others deep lakes or subterranean waters, while a few are found in mountain tarns at elevations of several thousand feet above the sea. Without exception nocturnal in their habits, spending the day in slumber either concealed in hiding places on land, or at the bottom of the water in their aquatic haunts, and venturing abroad only at evening or after heavy rain, they are all difficult of observation, and consequently much still remains to be learned with regard to their mode of life. The terrestrial species generally frequent soft, shady, damp spots, but occasionally narrow valleys or forests where they conceal themselves under stones or fallen trunks of trees, or in holes in the earth. During their permanent or temporary sojourn in the water, the adults of those species unprovided with external gills are obliged to come periodically to the surface in order to breathe, and while in that element all are less completely nocturnal than when on land. Such species as are inhabitants of cold regions undergo a period of torpidity during the winter months; while in tropical regions others become quiescent when their haunts are dried up. They exhibit a wonderful tenacity of life, and when dried up in mud, or frozen in ice, will awaken at the first shower of rain, or when their icy bonds are dissolved by the sun's rays. They have also the capacity of reproducing lost limbs, apparently any number of times. Although on land the majority of species are slow and sluggish in their movements, some salamanders from the south and west of Europe, belonging to the genera *Salamandrina* and *Chioglossa*, run with the celerity of lizards; while others, again, climb sloping or perpendicular faces of rocks, like geckoes. In the water all swim quickly, mainly by means of serpentine movements of the tail; although the water newts are perhaps the most expert swimmers. All are carnivorous in their diet, feeding chiefly upon mollusks, worms, spiders, and insects. Their breeding habits are peculiar in that there is usually no union between the two sexes; the females seizing the packets of spermatozoa deposited by the males, and conveying them to their own reproductive chambers. While some species lay eggs, in other

cases the eggs are hatched within the bodies of the female parent, and the tadpoles born alive, sometimes in a highly advanced stage of development. In the case of the common salamander, during the breeding season the male enters the water first, and is followed shortly afterward by the female, who gives birth to her tadpoles; but in the Alpine salamander, the young are born on land. The water newts, on the other hand, lay eggs which are attached to the stems and leaves of aquatic plants. The majority of the terrestrial forms pass the earlier stages of their existence in the water, not leaving this element till their lungs have become fully developed. In the tadpole stage all the members of the order are remarkably alike, and this resemblance forbids any wide separation of species like the olm, in which the external gills are retained, from the true newts and salamanders, in which these appendages are lost at an early period.

Although some of the larger kinds prey upon small fish, none of the newts and salamanders can be said to be harmful to man; while the terrestrial forms are defended against all foes, except fish, frogs, and snakes, by the poisonous secretion exuded by the glands of their skins; water newts are, however, devoured by aquatic birds and mammals. The reputed noxious characteristics of the common salamander, and its alleged immunity to the effects of fire, are, of course, purely fabulous. The existing members of the order are divided into four families.

THE SALAMANDER TRIBE

Family SALAMANDRIDÆ

Comprising the typical members of the order, this family is specially characterized by the absence of gills in the adult condition, the presence of upper jawbones or maxillæ, as well as of teeth in both the upper and lower jaws, and likewise by the development of distinct eyelids. The family, which includes by far the greater majority of the order, is divided into four subfamilies, the first of which is characterized by having the teeth on the palate of the skull arranged in two longitudinal series, diverging posteriorly, and inserted on the inner margin of two backwardly-prolonged processes of the palatine bones. The median parasphenoid bone on the base of the skull is devoid of teeth, and the bodies of the vertebræ are convex in front and concave behind.

Typical
Sala-
manders

The typical genus of the first subfamily (*Salamandrinæ*) is represented by three species, ranging from Central and Southern Europe to the Caucasus, Syria, and Algeria, of which the best known is the common spotted salamander (*Salamandra maculosa*). As a genus, these salamanders are characterized by the large and suboval tongue being free on the sides, and to a small degree also behind; by the palatine teeth forming two curved series; by the presence of four front and five hind-toes; and likewise by the nearly cylindrical section of the tail. The spotted species which varies in length from seven to nine inches, may be recognized by the length of the tail being slightly less than that of the head and body, and still more readily by its brilliant black

and yellow coloration, The head is depressed and nearly as broad as long; while the stout body is likewise somewhat depressed, without any crest along the middle of the back; and the short toes are devoid of any connecting webs. The smooth and shining skin is covered on the upper parts with pores, from which exudes a viscid and acrid secretion, having decidedly poisonous properties. The yellow markings on the head, back, and tail are arranged in two longitudinal series, broken up into more or less irregularly-shaped patches. The species is an inhabitant of Central and Southern Europe, Algeria, and Syria; and is the one which from time immemorial has been dreaded, not only on account of its undoubtedly poisonous properties, but likewise owing to the extraordinary superstition that if thrown on a fire it would not be consumed. Frequenting moist and shady spots, either in the mountains among rocks, or in valleys and forests, the salamander passes the daytime in a kind of torpid condition, only issuing forth from its hiding places among stones or roots of



SPOTTED SALAMANDER.
(Natural size.)

trees either during rainy weather or after nightfall; its skin being quickly dried up if exposed to the direct rays of the sun. Its movements on land are slow and sluggish, its gait being a crawl with a marked lateral movement; but in water the creature swims strongly, mainly by the aid of its tail. Although frequently found in the neighborhood of its fellows, this salamander can scarcely be termed a sociable creature; and it is only during the breeding season that the two sexes live in company. From the slowness of its own movements, it is only slow-moving creatures such as snails, worms, and beetles that the salamander can capture for its food; although it is stated to occasionally kill small vertebrates. Generally a large quantity of food is consumed, after which there is a long fast, sometimes lasting for as much as a month. During the pairing season, which is in April or May, both sexes betake themselves to the water, when the females collect the spawn deposited by the males. Although the young are usually born alive, it occasionally happens

that eggs are laid by the female, from which the young almost immediately make their escape. The number of tadpoles produced at a birth is very large, as many as fifty eggs being frequently found within the body of the female; while an instance is on record where upward of forty-eight young were born within four-and-twenty hours. More generally, however, from eight to sixteen, and less commonly from twenty-four to thirty tadpoles make their appearance into the world during a period of from two to five days. Generally all these are in an equally advanced state of development; but sometimes in captivity both eggs and tadpoles are produced simultaneously, the former being translucent and showing the young tadpoles curled up within them. The tadpoles, which are generally produced in clear, running water, are blackish gray in color, with a more or less well-marked greenish tinge; but there are small golden spots on the back, which gradually increase in size with



ALPINE SALAMANDER.

(Natural size.)

advancing age. The skin also gradually becomes less shining and smooth, while at the same time the gills shrink, till about August or September the young salamanders quit the water for a terrestrial life. A few may, however, remain till as late as October. It is remarkable that the young salamander is rather inferior in size to the tadpole in the latest stage of development; and it is not yet known for how long a period it continues to grow after leaving the water. In aquaria salamanders develop more quickly, and have been known to leave the water within three weeks. The winter sleep generally takes place in moss-lined crannies, well protected from the frost, and may endure till the commencement of April.

Alpine Salamander

The Alpine or black salamander (*S. atra*), inhabiting the Alps at elevations of from three to ten thousand feet, is a smaller animal than the last, from which it may be at once distinguished by its inferior dimensions. Ranging from the Alps into Styria, Carinthia, and some of the mountains of Württemberg and Bavaria, this species inhabits moist woods or the banks of mountain streams, where it is generally found in small family parties, which conceal themselves after the manner of their kind beneath stones and moss, or at the roots of the Alpine rose. Although resembling the spotted salamander in producing living young, this species differs in that never more than two are born at a time. The most remarkable circumstance connected with the reproduction of the species is, however, that from thirty to forty eggs are found in the oviducts of the females, out of which only one develops in each oviduct, at the cost of the remainder, which form a glutinous mass surrounding the developing egg, and in which the liberated tadpole can afterward freely move. There are also some fifteen unimpregnated eggs in each oviduct, which serve as the food of the newly-hatched tadpole. The tadpole, which does not attain its full size till after birth, lies in the oviduct of the female with its tail curled, but is capable of moving and even turning round. Its gills are of unusual length, being nearly half as long as the whole body; but before birth these shrivel up and are represented by mere knobs, so that the whole of the tadpole stage is passed through within the maternal body. Tadpoles that have been taken from the oviduct before completing their development will, however, live in water like those of the other species; thus proving that the species originally went through a temporary aquatic existence. Although the two young salamanders are generally born at the same time, occasionally one develops more rapidly than the other, so that there may be an interval of several days between the births of the two. At the pairing seasons these salamanders enter the water for a few hours, but are otherwise purely terrestrial. The third representative of the genus is the Caucasian salamander (*S. caucasica*), distinguished from both the others by the tail being longer than the head and body. In color this species is black, with irregular rows of round yellow spots down the back.

Spanish Salamander

This species (*Chioglossa lusitanica*) is the sole representative of a genus distinguished from the last by the tongue being supported on a median protrusile pedicle, and consequently free everywhere except on the front half of the median line. Considerably smaller than the spotted salamander, this species is dark brown in color, rather lighter above than below, with two broad reddish-golden bands along the body, separated from one another by a dark line along the middle of the back. It inhabits the northwestern districts of Spain and the whole of Portugal.

Newts

The newts (genus *Molge*) form an extensive group, of aquatic habits, spread over Europe, Northern Asia, and North America, and are the only members of the order found within the limits of the British Islands. Having the same number of toes as the salamanders, they are distinguished by the highly-compressed and rudder-like tail, as well as by the frequent presence of a fin-like crest down the middle of the back, which often attains a special development in the males during the breeding season. With the exception of the

crested newt, the skull differs from that of the salamanders by the presence of a ligamentous or bony arch connecting the frontal with the squamosal bone; and the palatine teeth form two nearly straight or slightly-curved series. The tongue is free along the sides, but may be either attached or more or less free behind. The genus may be divided into two main groups, according to the presence or absence of a crest down the middle of the back of the males; and each of these may be further subdivided according to the characteristics of the so-called fronto-squamosal arch.

Crested Newt Belonging to the group in which the males are provided with a dorsal crest, this species (*M. cristata*) differs from all the others in the absence of a fronto-squamosal arch to the skull; while it is further characterized by the serration of the crest, and the orange and black-spotted coloration of the under parts. The total length varies from five to five and three-fourths inches, and the toes of both limbs are free. The color of the upper parts is brown, blackish, or olive, with more or less distinct black spots; the sides are spotted with white; and the under parts orange, with black spots or marblings. During the breeding season the head of the male is marbled with black and white, and there is a silvery band along the sides of the tail; while in the female the under surface of the tail is uniformly orange. The toes are yellow with black rings. An inhabitant of Britain, this species is spread over the greater part of Europe, extending as far north as Sweden, but unknown in Italy, and ranging eastward to Greece, Turkey, and Russia. Not improbably Blasius's newt (*M. blasii*), from Northwestern France, is a hybrid between the present and the next species, having the form and coloration of the former, but the fronto-squamosal arch of the latter.

Marbled Newt Of the other European species, one of the handsomest is the marbled newt (*M. marmorata*) from France, Spain, and Portugal, of which a male and female are represented in the illustration on p. 2663. Having a ligamentous fronto-squamosal arch to the skull, this species is specially distinguished by the smooth dorsal crest of the male, and by the under parts being generally dark with white dots. The total length is about five and a quarter inches. In general color the upper parts are green with black marblings; the crest of the male being ornamented with black and white vertical bars, while in the female an orange streak runs down the middle of the back. The sides of the tail have a silvery-white band most distinctly marked in the male during the breeding season; the under parts are brown or grayish, with more or less distinct darker spots, and dotted with white; and the green toes are marked with black rings. Rare in France, this species is common in Spain and Portugal; and it lives in ponds and streams only in the early spring, spending the remainder of the year on dry land.

Alpine Newt The next species for notice is the Alpine newt (*M. alpestris*), represented in the illustration on p. 2656, which differs from the last by the much lower dorsal crest of the males, and likewise by the uniformly orange color of the under parts. In size it is a comparatively small species, varying from three and a quarter to four inches in length. In color the upper parts, which may be either uniform or with darker marblings, vary from brown, grayish, to purplish; the sides have a series of small black spots on a whitish ground, beneath which, in

the male during the breeding season runs a sky-blue band; the crest on the back and tail is white with round black spots; the throat is frequently dotted with black; the under parts are uniform orange or red; and the lower edge of the tail of the female is orange spotted with black. The Alpine newt inhabits France, Belgium, Holland, Germany, Switzerland, Austria, and the north of Italy.



MALE AND FEMALE OF MARBLED NEWT.
(Natural size.)

Common Newt A fourth European representative of the genus is the small common newt (*M. vulgaris*) which belongs to the same group as the preceding, and is distinguished by the festooning of the dorsal crest, the lobate hind-toes of the male, and the black-spotted under parts. Abundant in almost every English pond and ditch, where the water is sufficiently clear, this species ranges all over Europe, with the exception of the south of France, Spain, and Portugal, and is likewise widely distributed in temperate Asia. It measures about three and a quarter inches in length, and has a nearly smooth skin. The upper parts are brown or

olive in color, with darker spots, larger and more rounded in the male than in the female; the head is marked with five longitudinal dark streaks; the under parts are yellowish, with a median orange or reddish zone, and marked with black spots in the male, and dots of the same in the female. In the latter the lower edge of the tail is uniformly orange, whereas in the male it is red, bordered with blue and interrupted by vertical black bars.

The last of the European species we can notice at length is the **Webbed Newt** (*M. palmata*) distinguished from all the preceding by the bony fronto-squamosal arch to the skull, and likewise by the webbed hind-toes of the male. This is the smallest species yet noticed, its length not exceeding three



MALE AND FEMALE OF COMMON NEWT.
(Natural size.)

inches. The color of the upper parts is brown or olive, with small dark spots on the body and longitudinal streaks on the head. In the male there are also minute brown speckles on the head; and the dorsal, as well as the upper part of the caudal crest, together with the hind-feet are blackish. Except for a median orange zone, the under surface is uncolored, although there may be a few small blackish dots; there are a series of spots along the upper and lower borders of the tail, and the crest on its lower surface is orange in the female and bluish gray in the male. The webbed newt has been recorded from Britain, France, Belgium, Holland, Switzerland, Western Germany, and the North of Spain.

With the exception of the banded newt (*M. vittata*) of Asia Minor and Syria, distinguished by the presence of a black band along each side of the body, all the other members of the genus are devoid of a crest along the

back in a male. One of the most remarkable of these is Waltli's newt (*M. walllii*), from Spain, Portugal and Tangiers, distinguished by the elongation of the ribs, which in some instances actually perforate the skin, so as to form a row of sharp points on each side of the body. In a fossil state the genus has been recorded from the lower Miocene paper coal deposits near Bonn.

Habits

Since the general habits of all newts are very similar, one account will serve for the entire group; but it must be remembered that whereas the whole of them are aquatic during the breeding season, at the close of that period some species leave the water and live for the rest of the summer on land; while nearly all seem to pass some portion of the year out of the water. Newts generally prefer clear and running water, with plenty of aquatic plants on which to deposit their eggs. On land they are somewhat awkward and slow, but in water they swim with great rapidity by the aid of their oar-like tails, their hind-legs being pressed close to the sides of the body; their mode of progression being thus exactly the opposite to that of a frog. They often stand upright in the water when coming to the surface to breathe, after which they will sink to the bottom with a snake-like movement in search of prey. When on land, they seek shelter beneath stones and roots, or in holes in the ground, and in such situations often undergo their winter sleep, although such as live in deep water pass the cold season of the year in a kind of torpor at the bottom. All newts are carnivorous or insectivorous, and the crested newt feeds largely on the tadpoles of the common frog, while the larger species will prey on the smaller members of their own genus. Although there is considerable difference in the spawning time of the various species, the eggs are generally deposited during May or June, the female laying each egg singly on the edge of the leaf of some water plant, which is folded together by her hind-feet, and thus held by the viscosity of the egg. In the course of a few days, after its deposition, the white embryo assumes an elongated form within the egg; and soon it is seen to be folded upon itself, with the gills well developed, and in advance of them a pair of lobes by which the liberated tadpole affixes itself to aquatic plants. When about a quarter of an inch in length, and while the gills are still simple, the tadpole bursts its envelope; the front limbs being represented merely by a pair of small knobs behind the gills. When hatched, it swims about in an aimless kind of a way till it strikes against some object to which it can easily attach itself, and after a short time starts on another voyage. Development now proceeds apace, and in the course of two or three weeks the tadpole will have attained a length of about half an inch, while the gills will have become elegantly branched, and the fore-limbs well developed. At this period the eyes assume their permanent characteristic, and the mouth has become terminal, while the lobes for attachment to plants are well-nigh absorbed. Still later the front feet, which had previously been only digitated, acquire four distinct toes, and the hind-limbs make their appearance and gradually assume their full proportions; but the gills have become still more complex. From this date the latter appendages gradually diminish in size, and shrivel, while the lungs are at the same time developed, until finally, about the latter part of the autumn, the creature has completed its metamorphosis and passed from the condition of a fish to that of a reptile. Although

in most cases newts shed their skin piecemeal, in the crested newt it has been observed to be cast entire.

The presence of only four toes to each foot, and of a bony fronto-squamosal arch to the skull, are the most distinctive features of the little spectacled salamander (*Salamandrina perspicillata*) of Italy, the sole representative of the genus to which it belongs. It is, however, further distinguished by its slender form, and also by its somewhat compressed and rapidly tapering tail, furnished both above and below with a longitudinal keel, as well as by the palatine teeth being arranged in two parallel series diverging posteriorly. The tongue is very similar to that of the genus *Chioglossa*. Reaching from rather more than three to nearly four inches in length, this pretty little salamander has a warty skin, and is generally black on the upper parts, although there is a triangu-



SPECTACLED SALAMANDER.
(Natural size.)

lar or chevron-shaped yellow mark on the top of the head. Beneath, the chin is white, the throat black, and the rest of the under parts white, usually marked with black spots; the lower surface of the tail and adjacent part of the body is, however, bright carmine. The tarantolina, as this salamander is termed in Italy and Sardina, inhabits cool, shady spots on the flanks of the mountains, where it feeds chiefly upon ants and spiders, and is active at all seasons of the year, having been seen abroad even in January. Although it appears that the pairing takes place on land, the females resort to the water in March to deposit their eggs, those that are first to arrive taking the best places, such as sheltered corner of rock, where the spawn will be less likely to be washed away by floods. The young are hatched in about three weeks, and generally leave the water in June. In its movements on land this salamander is as active as a lizard.

There are two other existing genera of the subfamily under consideration, both differing from the preceding forms in that the maxilla or upper jawbone is more or less fully in contact with the pterygoid bone. Both have a fronto-squamosal arch, but whereas in *Tylotriton* this is bony throughout, it

is ligamentous posteriorly in *Pachytriton*, which has also the tail cylindrical at the base, instead of compressed throughout. The former genus, in which the skin is extremely warty, is represented by one species from Siam and the Eastern Himalayas, and a second from the Liukiu islands, while the latter is known only by a single Chinese form.

Axolotls Although properly speaking the term axolotl applies only to the permanent larval form of the Mexican representative of the genus *Amblystoma*, it will be found convenient in practice to make it include all the members of that group, whether mature or immature. Together with certain other genera,



LARVAL STAGE OF MEXICAN AXOLOTL.
(Two-thirds natural size.)

Amblystoma constitutes a second subfamily (*Amblystomatinae*) distinguished from the *Salamandrinae* by the teeth on the palate forming a transverse or posteriorly converging series, and being inserted on the hinder portion of those bones known as the vomers, as well as by the bodies of the vertebræ being cupped at each end. The type genus is specially characterized by the palatal teeth forming a nearly straight or angulated series, not separated by a space in the middle line; and likewise by the radiating folds of skin on the tongue, which are oval or nearly circular in form, with the sides completely and the front partially free. There are five hind-toes, and the tail is more or less compressed. Represented by a number of North-

American species, one of which ranges as far south as Mexico, the genus has also one Asiatic member, inhabiting the mountains of Siam, probably at a great elevation.

The majority of axolotls pass from the tadpole to the salamander stage in the ordinary way, but this is not the case with the Mexican race of the Mexican axolotl (*A. tigrinum*) which likewise extends over a large area in the United States. The adult form is shown in our second illustration; and in this condition the head is large and depressed, and has a broad and blunt muzzle, the limbs being stout, with short toes, and the rather long tail distinctly compressed, and keeled above and below near the extremity. The shining skin is finely granulated, and the general



ADULT OF MEXICAN AXOLOTL.
(Two-thirds natural size.)

color brown or blackish, with more or less numerous yellow spots, which may be arranged in transverse bands. In the United States, we believe, the transformation from the larva to the adult goes on in the ordinary manner; but the case is very different in Mexico. The city bearing that name is, as our readers are doubtless aware, surrounded by an extensive lake; while the country itself is characterized by its extreme dryness. In this lake dwell the creatures represented in our first illustration, which are known to the natives by the name of axolotl. It will be seen from this figure that they resemble the tadpole stage of ordinary salamanders and newts in having large branching gills, and a deep rudder-like tail; and the natural conclusion would be that they are larval forms. However, in the Mexican lakes, the axolotls remain permanently in the water, retaining their gills throughout life,

and laying eggs, as if they were adult; and it was consequently long considered that they belonged to a type with persistent gills. It was not, indeed, until the year 1865, that light was thrown on the history of these remarkable creatures by six examples which had been living for more than a year at Paris. These comprised five males and one female, and in the middle of February the latter began to lay eggs, which in the course of a month hatched into tadpoles like their parents. In the following September the gills and crest of the tail of one of these began to shrivel, while the head increased in size, and yellow spots made their appearance upon the dark skin. Toward the end of the same month, and in the early part of October, similar changes took place in the others, and soon afterward the whole four assumed the appearance of the salamander, which had been previously described as *Amblystoma tigrinum*. Subsequently experiments were made with other young axolotls by placing them in a glass vessel filled with water, but with rocks at one end, so that the creatures could creep out and expose themselves to the air as much as they pleased. After a day's interval the amount of water in the vessel was diminished; and almost immediately the gills of the axolotls began to shrink, and in the course of time, during which they dwelt chiefly in damp moss, the creatures gradually developed into air-breathing salamanders. It has been inferred from these remarkable experiments that the Mexican axolotl, like the other members of the genus to which it belongs, originally went through the normal series of transformations; but that, owing to the dry nature of the country it inhabits, it has acquired the habit of retaining the larval condition permanently. From its being able to breed in this state, it may further be inferred that the tadpole stage was originally the permanent condition of all members of the order, and that the salamander stage is a later development.

Other Genera There are six other genera, belonging to the subfamily *Amblystomatinae*, of which *Hynobius* is represented by several Japanese species. *Salamandrella*, distinguished by having only four hind-toes, is a Siberian type, with two species; *Onychodactylus*, which may be recognized by its black claws, is known by one species from Japan; while *Ranidens*, from Eastern Siberia and North-eastern China, *Batrachyperus* from Moupin in Tibet, and the Californian *Dicamptodon*, all of which have the palatal teeth arranged in two arches, with their convexity forward, and separated by a wide space in the middle, are likewise respectively represented by a single species. The two remaining subfamilies, which are exclusively American, can receive only very brief notice. In the first of these (*Plethodontinae*) the series of palatal teeth is transverse and situated on the hinder part of the vomers; while there are also teeth on the parasphenoid bone; the bodies of the vertebræ being cupped at both ends. Of the five genera, *Plethodon*, with the tongue attached along the middle line to the anterior margin, and five hind-toes, is North American, where it is represented by several species. On the other hand, the large genus *Spelerpes*, which has the tongue attached only by a central pedicle, and all its edges free, ranges into Central America and the West Indies. The fourth subfamily, *Desmognathinae*, differing from the last by the bodies of the vertebræ being cupped behind and convex in front, is represented by *Desmognathus* from North America generally, and *Thorius* with one Mexican species.

THE FISH-LIKE SALAMANDERS

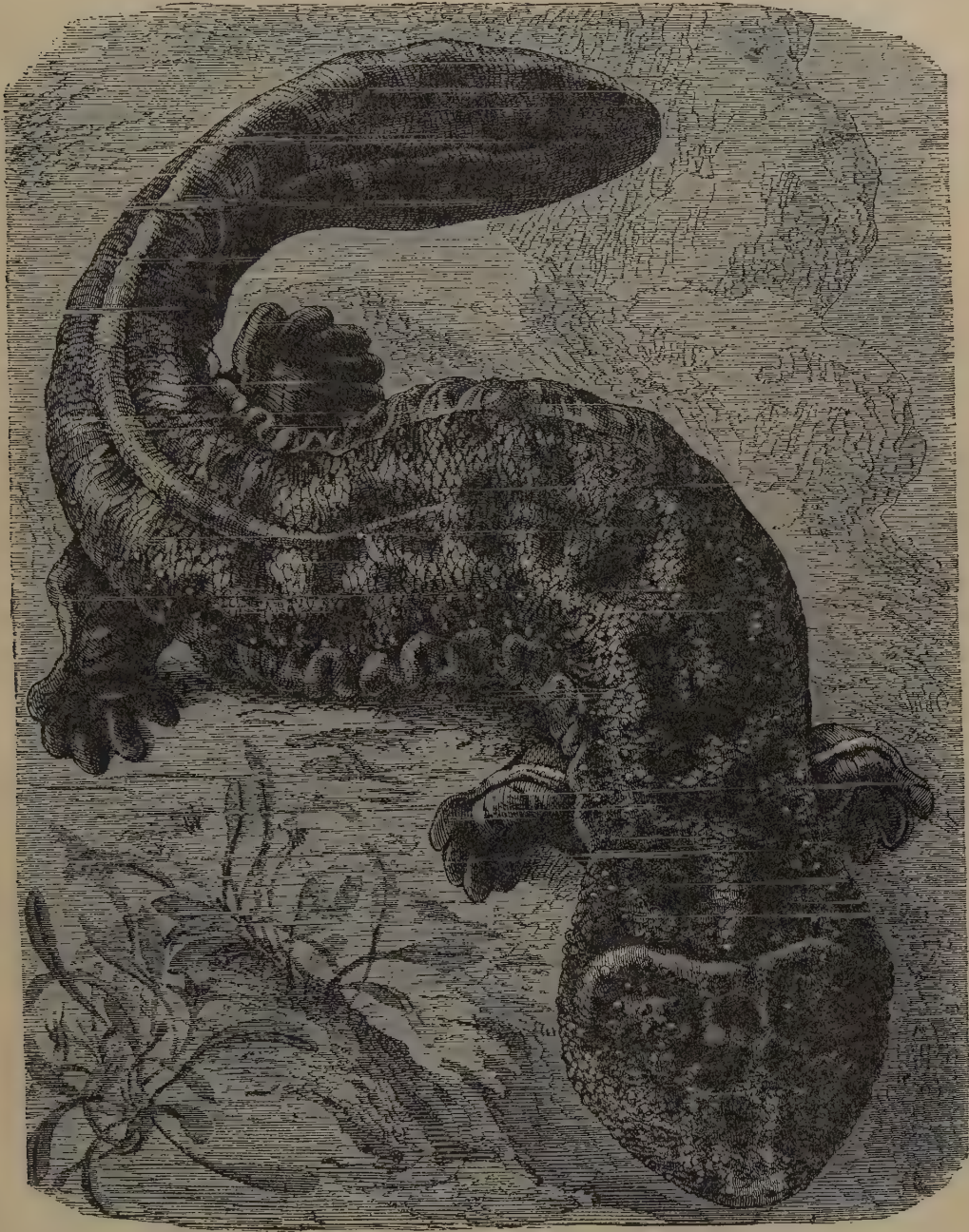
Family AMPHIUMIDÆ

The members of this family, which, for want of a better name, may be collectively designated by a translation of their German title, *fischmolche*, differ from the *Salamandridæ* in the absence of eyelids. The bodies of their vertebræ are always cupped at both ends. They are all characterized by the weakness of the limbs in comparison to the body, and the wide separation of the front from the hinder pair. They live chiefly or entirely in the water, and breathe by means both of lungs and internal gills in the adult state. Only three genera are known, the first two of which are so closely allied that it is a question whether they are really entitled to rank as distinct.

Giant Salamander The earliest record that we have of this family is a skeleton from the upper Miocene of Oeningen in Basle, described by Scheuchzer in the year 1726, under the name of *homo diluvii testis*; the learned doctor believing that he had to do with a human skeleton, which, like all fossils at that time, was considered to have been buried by the Noachian deluge. This fossil species, which was fully as large as the existing giant salamander, together with a smaller extinct species from lower Miocene strata near Bonn, probably belong to the same genus. The giant salamander (*Megalobatrachus maximus*) was first discovered in 1820 by Siebold in the rivers of Japan, but has been subsequently obtained from China. As a genus, it is characterized by having four front- and five hind-toes, the absence of a gill opening, and the presence of two internal gill arches. The tongue covers the whole of the floor of the mouth, to which it is completely adherent; while the palate has a curved series of teeth on the vomers, parallel to those on the margin of the upper jaw. In form the giant salamander is very stoutly built; the head being very large, wide, and flattened, with the muzzle regularly rounded, the small nostrils situated near the extremity, and the eyes very minute. The body is likewise broad and depressed; the legs and toes are short, the outer ones, as well as the outer side of the hind-leg, having a membranous fringe; and the short tail is strongly compressed, with a fin above and below, and its tip rounded. The skin, which forms a thick fold along each side of the body, is very warty, especially on the head; and the general color is brown with black spots, becoming lighter on the upper parts. Although the ordinary length of this salamander is about thirty-five inches, it is stated at times to grow to as much as forty-four inches.

Originally purchased by Siebold in the market of Nippon, the giant salamander is now ascertained to inhabit not only the mountain streams of that island, but likewise those of several parts of the Japanese mainland, as well as of Western Central China. Nowhere very abundant, the creature generally frequents the upper courses of small mountain streams at elevations of from seven hundred to five thousand feet above the sea level; some of these streams being not more than a foot in width, and completely covered over with grasses and other herbage. The water is clear; and

usually while the full-grown salamanders curl themselves round masses of rock in the bed of the stream, the younger ones live in holes. Except in search of food,



GIANT SALAMANDER.
(One-third natural size.)

which consists of worms, crustaceans, fish, and frogs, the animals do not leave their hiding places, and then only at night, while they never venture on land. In confinement they are extremely slow and sluggish in their movements, only exhibiting any marked activity when they rise to snap at a worm or other tempting morsel. In spite of its large size, the female lays very minute eggs, which are generally deposited in August and September. The smallest young yet observed had a length of about six inches, and in every respect resembled the adult. Probably however, at an earlier stage of development, external gills were present; and indeed, in an illustrated Japanese book, the young of the giant salamander is represented with these appendages. Further evidence of this is afforded by the circumstance that



HELLBENDER, OR MISSISSIPPI SALAMANDER.
(One-third natural size.)

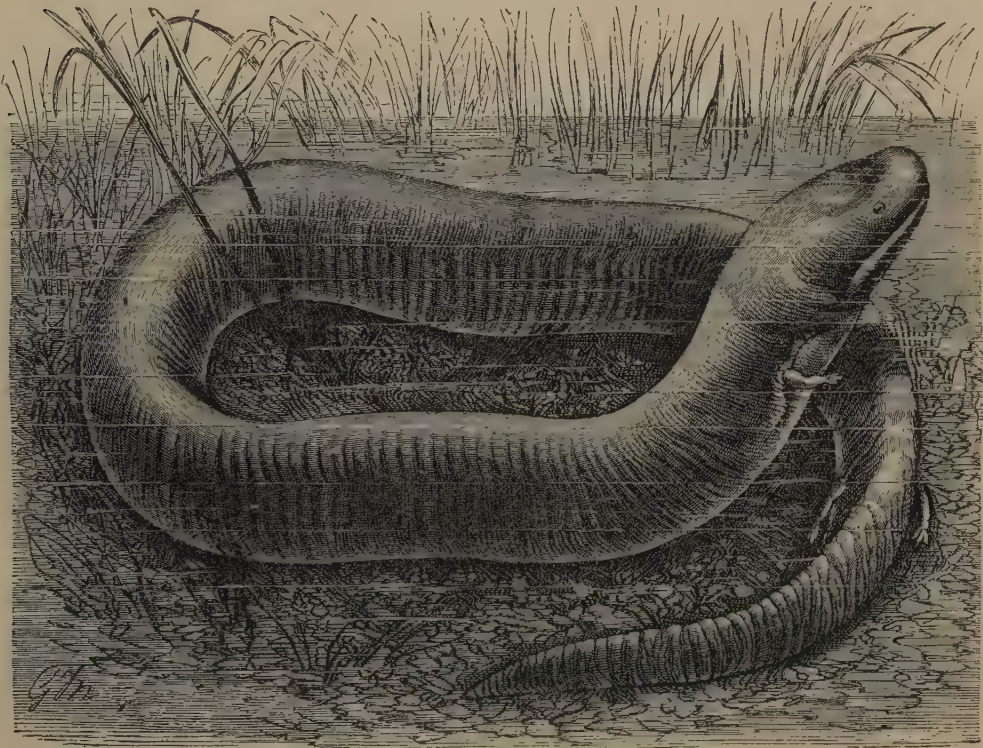
young specimens have been taken in which the gill openings were retained. The first two living examples were taken to Europe in 1829 by Siebold, and were fed on fresh-water fish brought from Japan, but when these began to fail, the male devoured his unfortunate partner. When suitable food was procured, the male, however, flourished and increased rapidly in size, surviving till the year 1881, when it died in Amsterdam.

Hellbender

Under this euphonious name is designated in its native country the Mississippi salamander (*Cryptobranchus lateralis*), which differs from its Asiatic cousin by the presence of a gill opening, at least on the left side of the neck, and likewise by the presence of four pairs of gill arches, and by the anterior

border of the tongue being free. In general form this salamander closely resembles its larger relative; the skin being porous and rather smooth, and the head covered with scattered wart-like tubercles. The color is brown or grayish, with darker blotches; but the tips of the toes are yellowish. In length this species, which is the sole representative of its genus, reaches about sixteen or seventeen inches; and it inhabits all the tributaries of the Mississippi, and ranges into North Carolina.

In these streams it crawls or swims in a sluggish manner, seldom leaving the water, although it can exist on land for twenty-four hours or so at a stretch, feeding on crustaceans, worms, and fish, and being not unfrequently taken on the angler's



THREE-TOED OR EEL-LIKE SALAMANDER.
(One-half natural size.)

hook. From the circumstance that the tadpoles have never been observed, it would seem that the larval stage must be of very short duration; and the only thing known about the development of the species is that the eggs are of relatively-large size. Although perfectly innocuous, the hellbender is regarded by American fishermen as a most noxious and poisonous reptile. It was first taken alive to Europe in 1869, since which date it has been frequently exhibited; and if fed on meat or the heads of fish will rapidly increase in size, although it appears to voluntarily undergo long fasts. While in the water it has been observed to make the air from its

lungs pass over the gills, with the apparent object of more fully oxygenating the blood in the latter.

Three-Toed Salamander The eel-like or three-toed salamander (*Amphiuma means*) represents another North-American genus, ranging from the Mississippi to South Carolina, and distinguished by its extremely elongated and eel-like form, and the small size of its limbs, each of which terminates in three or two minute toes. The tongue is indistinctly defined, covering the whole of the floor of the mouth, to which it is everywhere adherent; there is a gill aperture on each side of the neck, and four internal gill arches are present. The head is relatively small, with a rather long and narrowing muzzle, at the extremity of which are the small and widely-separated nostrils; the eyes are likewise minute; the lips are unusually thick and fleshy, and the short compressed tail is keeled superiorly. The smooth and slimy skin is of a uniform blackish-brown color, although rather lighter below than above. In total length, full-grown examples measure about thirty-one inches. From the difference in the number of the toes it has been thought that there are two species, but since the two-toed and three-toed forms are in other respects similar, it seems preferable to regard them as varieties or local races of a single species. These salamanders are inhabitants of muddy waters, frequently burying themselves in the mud at the bottom, in one instance to the depth of a yard or more, in thick clayey mud of the consistence of putty, in which they burrowed like worms. They also frequent the irrigation channels in rice fields, while they occasionally venture on land. Their food comprises fresh-water mussels, fish, beetles, other insects, and crustaceans. Beyond the fact that the female lays eggs, in which the tadpole lies coiled up until it attains several times the length of its chamber, little is known as to the breeding habits of this species.

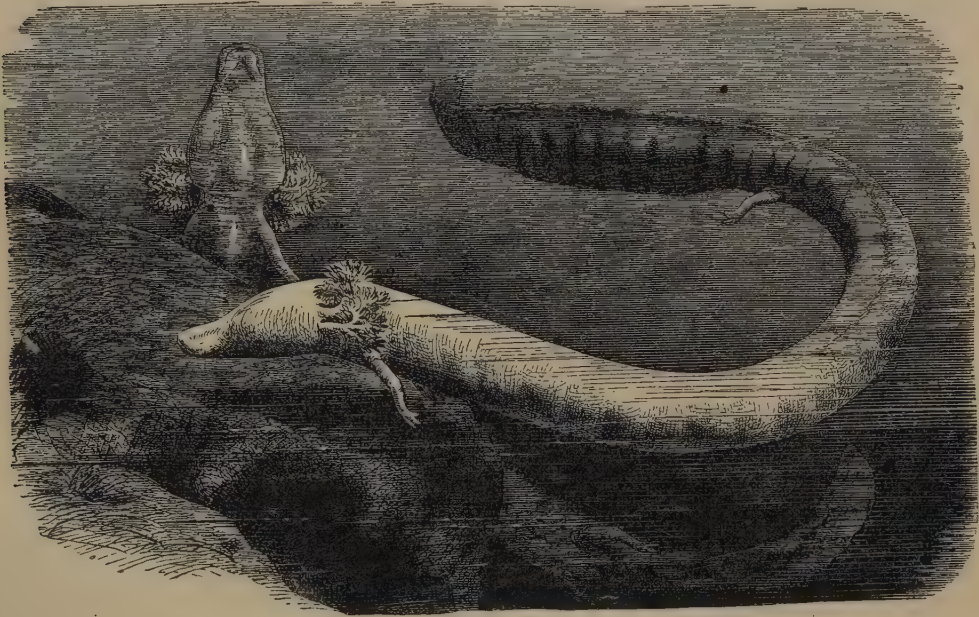
THE GILLED SALAMANDERS

Family *PROTEIDÆ*

Represented only by the curious olm of the subterranean waters of Carniola and other parts of Europe, and by an allied genus in North America, the gilled salamanders take their title from the permanent retention of external gills, on which account they may be regarded as some of the lowest representatives of the order. In addition to this primary feature, they are characterized by the absence of the upper jawbone or maxilla, although the premaxilla is present, and, like the lower jaw, furnished with teeth. There are no eyelids, and the bodies of the vertebræ are cupped at both extremities. There are differences in the external form of the two representatives; the olm being a long, snake-like creature with small limbs, whereas the American species resembles a salamander.

Olm Known for more than a couple of centuries, the remarkable creature to which Oken gave the name of olm is the sole representative of its genus, and is technically known as *Proteus anguineus*. From its American ally it

is distinguished by its elongated snake-like body and small and widely-separated limbs, of which the front pair are provided with three, and the hinder with only two toes. The eyes are concealed beneath the skin, the small tongue is free in front, and the palatal teeth are small and arranged in a double series. In the typical form from Carniola the head is elongate, with a long and narrow muzzle, truncated at the tip; the mouth being small, with large lips. The short and much compressed tail is provided with a fin, and rounded or bluntly pointed at the tip. The smooth skin is marked by twenty-six or twenty-seven grooves, corresponding to the ribs, and is uniformly flesh colored, with coral-red gills. In a variety from Dalmatia the snout is longer and narrower, and the number of costal grooves only twenty-four; while in a second variety, inhabiting Carinthia, the whole form is



THE OLM.
(Two-thirds natural size.)

stouter, the head shorter, with a rounded muzzle, and the number of costal grooves twenty-five. There is also a certain variation as regards color, apparently largely depending upon the amount of light to which the creatures have been exposed; some examples being reddish brown, and others darker with bluish black spots. The usual length is about ten inches.

Totally blind, the olm is found solely in the subterranean waters of the caverns of the Alps of Carniola, Dalmatia, and Carinthia; and has long been an object of the greatest interest to naturalists. It has been thought that the waters in which the olm lives were all connected underground, and that the creatures only came up during flood time; but the great distance from one another of the various localities where they are found is somewhat against this view. It is, however, only

when the subterranean waters are at their greatest height that the olms are captured by the peasants, by whom they are placed in glass jars, half filled with water and sold to tourists. In confinement, where they have been known to survive from six to eight years, they lie sluggishly all day at the bottom of their tank, only moving if a ray of light impels them to seek a darker corner. When in small vessels, where the water is not often renewed, they will frequently come to the surface to breathe, opening their mouths, and letting air pass through their gill openings; but in deeper, or frequently changed water, they breathe entirely by means of their gills. Many experiments have been made, with the view of ascertaining whether the olm will, under any circumstances, lose its gills, but hitherto without result. In captivity the food of these amphibians consists of mollusks, worms, and the minute creatures to be found among the leaves of water plants. In spite of having been kept for many years in captivity, it was not ascertained till 1875 that the olm lays eggs; and it was thirteen years later before any tadpoles were hatched in captivity. In April 1888, upward of seventy-six eggs were laid by a single female; and after a period of three months developed into tadpoles. These were very similar to the adult, but the tail fin extended three-quarters down the back; the eye was larger, and apparently more susceptible to light; and the hind-limbs were in the form of small knobs.

A very different looking animal is the furrowed salamander (*Necturus maculatus*) of Eastern North America and Canada, which takes its name from the strongly-marked fold of skin on the throat. In addition to its shorter and more lizard-like form, and relatively-longer limbs, it differs from the olm by having well-developed eyes, and four toes to each foot. The tongue is large, with the front border free; and the palatal teeth are large and form a single series. In color the smooth skin is brown, with more or less well-defined circular blackish spots, and lighter on the under parts than on the back. The total length is about a foot. An allied species (*N. punctatus*) inhabits the rice fields of the Southern States. The food is similar to that of the allied forms, and in winter these salamanders seek protection from frost by burrowing deep in the mud. They come at times to the surface to breathe, and will even venture on land; but they chiefly respire by means of their gills, and if the latter become entangled, they are carefully rearranged by means of the fore-foot.

TWO-LEGGED SALAMANDERS

Family SIRENIDÆ

The sole representatives of this, the last family of the Tailed Amphibians, are the two-legged salamanders of North America, of which there are two species, arranged under as many genera (*Siren* and *Pseudobranchus*). While agreeing with the preceding family in the permanent retention of external gills, they are distinguished by the total loss of the hind-limbs, and likewise by the absence of teeth in the margins of the jaws. The siren salamander (*Siren lacertina*), which

inhabits the Southeastern United States, may be compared to a snake furnished with a pair of short fore-legs and external gills; and is especially distinguished by the presence of three pairs of gill openings on the sides of the neck and the four-toed feet. The smooth skin is either uniformly blackish, or marked with small white dots, and the total length reaches to as much as twenty-eight inches. The Georgian two-legged salamander (*Pseudobranchus striatus*), on the other hand, has only a single pair of gill openings on the neck, and but three toes to the feet. These salamanders are stated to frequent swampy localities, especially pools of water beneath the roots of old trees, up the stems of which they will sometimes climb. A living example was received in England in 1825, where it lived till 1831. This specimen was fond of coming out of the water to rest on sand or among moss; and in summer ate worms, tadpoles, and various other small creatures, but became torpid from the middle of October till the end of April. That these salamanders can breathe entirely by means of their lungs, is proved by a specimen in an aquarium whose gills had been eaten off by a fish.



SIREN SALAMANDER.

THE CÆCILIANS OR WORM-LIKE AMPHIBIANS

Order APODA

The remarkable worm-like and blind amphibians forming this group are generally regarded as the representatives of a distinct order; although they are considered by Professor Cope to be merely a degraded branch of the Tailed Amphibians, to which they are allied through the fish-like salamanders. Be this as it may, the group is readily distinguished by the total absence of limbs, and the general worm-like appearance of the head and body; the tail being either rudimental or wanting. In the skull the frontal bones are distinct from the parietals, but the palatines are fused with the maxillæ. As regards their reproduction, these amphibians differ from the newts and salamanders in that the two sexes come together in the ordinary manner. Some of them are peculiar in having overlapping scales embedded in the skin, like fishes; and in all the eyes are either wanting, or are so deeply buried beneath the skin as to be entirely useless. The whole of the members of the group

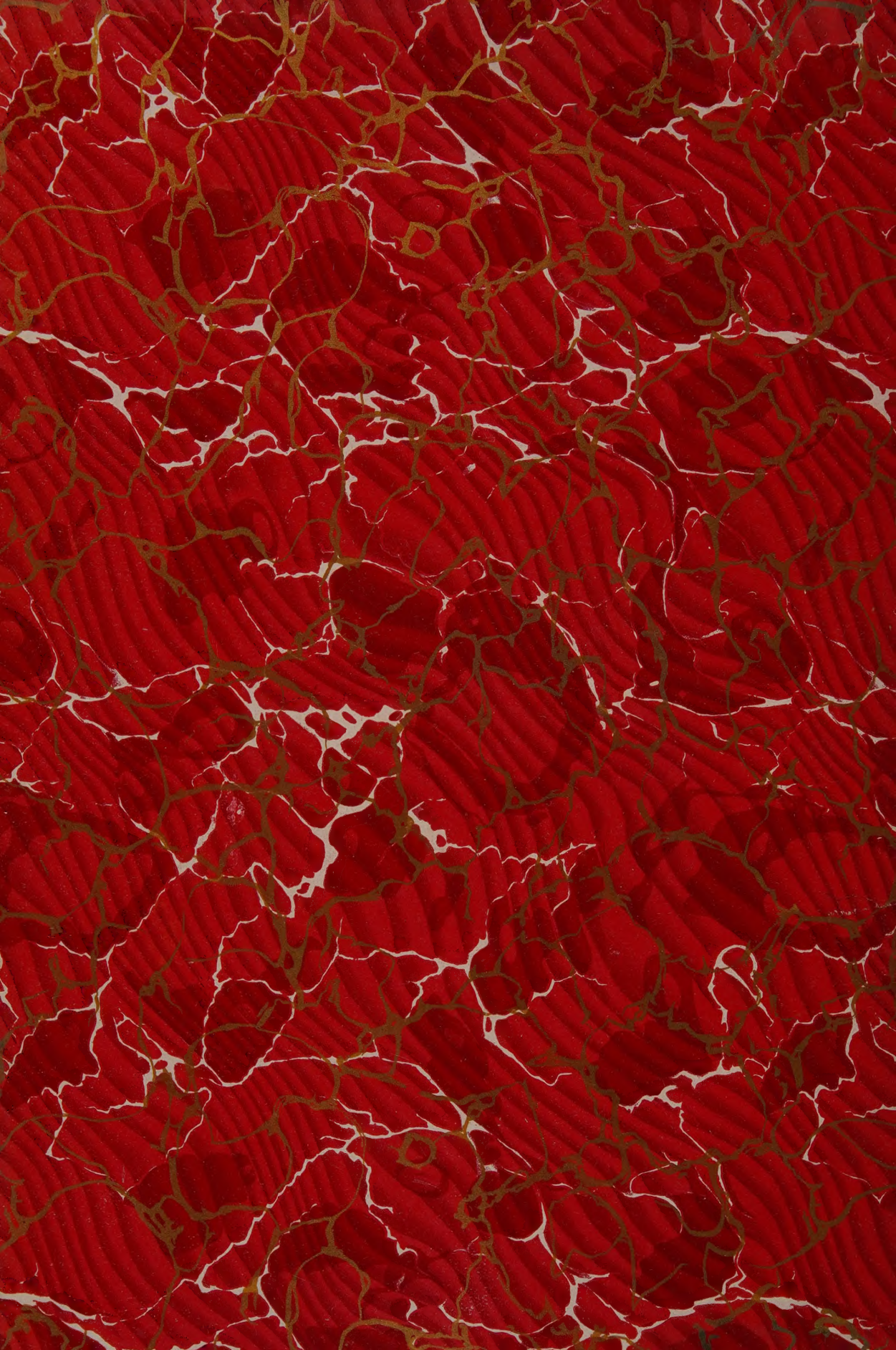
are burrowing in their habits; and in the adult state are completely terrestrial, laying eggs from which are developed gilled tadpoles that do not take to the water till some time after birth. The fourteen genera into which the group has been divided may all be included in the single family *Cæciliidæ*. Geographically, these amphibians are spread over the Indian region, Africa south of the Sahara, and Central and South America; but it is not a little remarkable that they are quite unknown in Madagascar, although two species occur in the Seychelles.

They may be divided into two main groups, from the presence or absence of scales in the skin; two of the best-known representatives of the group in which scales are developed, at least in some portion of the body, being the Oriental *Ichthyophis* and the South-American *Cæcilia*; one of the species of the latter genus being represented in our illustration. The common Cingalese species (*Ichthyophis*



A WORM-LIKE AMPHIBIAN, *Cæcilia*.
(Natural size.)

glutinosus), which ranges from Ceylon and the Eastern Himalayas to Sumatra and Java, inhabits damp situations, and usually burrows in soft mud. In some hollow near the water, the female (which measures about fifteen inches in length) lays a cluster of very large eggs, round which she coils her body, and proceeds to brood them after the manner of a python. After the young are hatched they remain in the egg moss until they have lost their external gills, after which they take to the water, to lead for a time an aquatic life. During this stage of their existence the head is fish-like, with large lips, and the eyes better developed than in the adult; and they have a gill opening on each side of the neck, and the tail is distinctly defined, much compressed, and furnished both above and below with fins. Of the group without scales, the genus *Gegenophis* is from Southern India, *Siphonops* from tropical America, and *Typhlonectes* and *Chthonerpetum* from South America.



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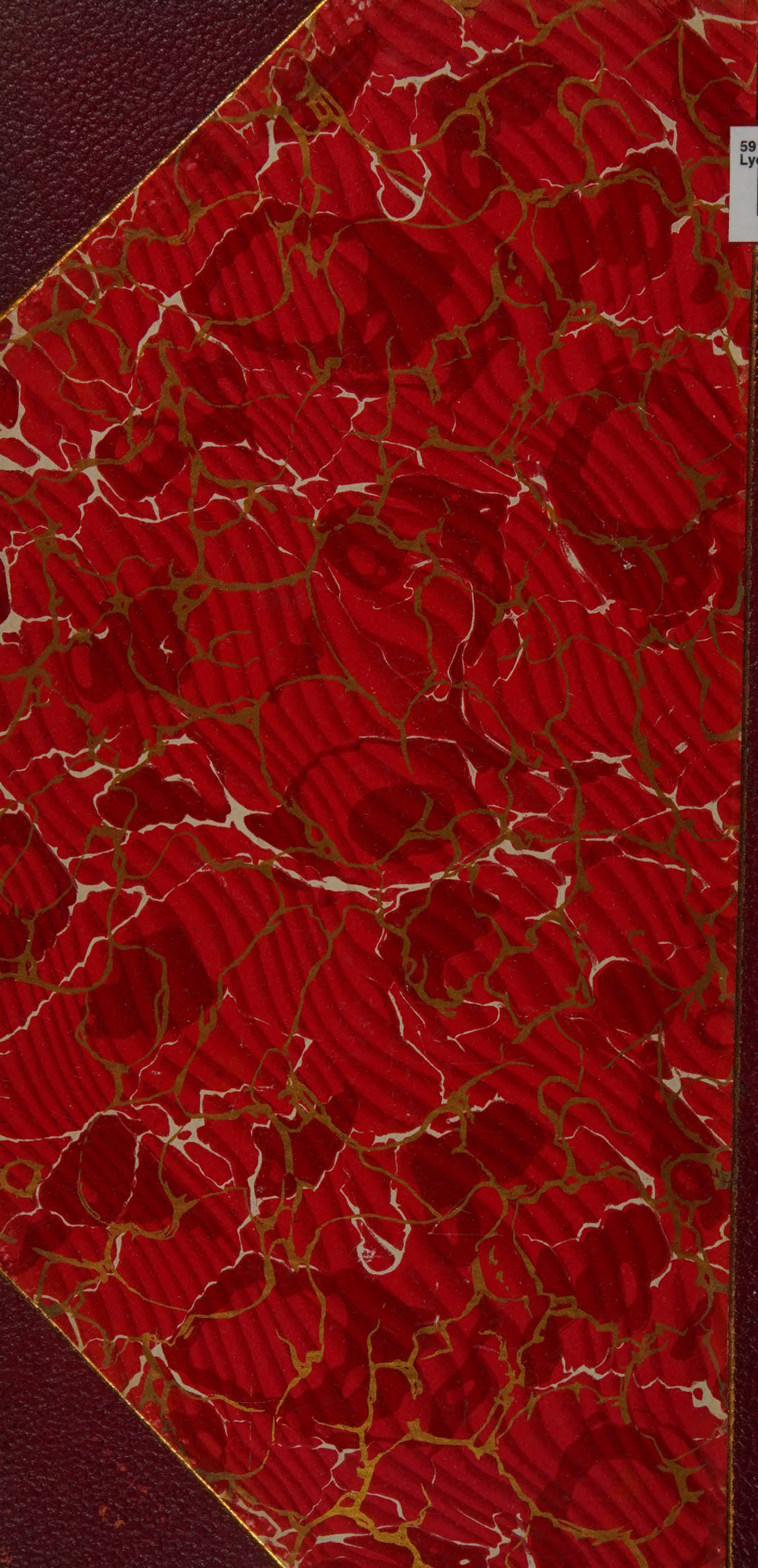
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